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BUREAU OF AERONAUTICS

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A HISTORY OF U.S. NAVAL AVIATION

BY

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CHAPTER I
THE BEGINNING OF AVIATION

Although a large number of experimenters gave their attention to the problem of mechanical flight previous to the last decade of the nineteenth century, nothing practical was achieved prior to that time. But with the perfection of the steam engine and the development of the internal combustion engine, there came inducement to sound experimentation bringing forth such well known scientists and inventors as Lilienthal, Maxim, Langley, and the Wright brothers.

Otto Lilienthal, a German, made the first successful flight in a man-carrying glider in 1891. This glider was a bird-shaped apparatus made of willow wood with waxed sheeting. It used cambered wings, weighed 40 pounds, and had a wing spread of 107 square feet. There were no control levers and his only method of steering was to shift the balance of the machine by swinging his legs one way or the other. Lilienthal continued his man-carrying experiments with gliders and soon thereafter developed tail surfaces for steering vertically and horizontally. He lacked the third rudder or aileron control, however, and was still dependent on the shift of body weight for preserving the lateral balance. Having executed nearly two thousand flights with several monoplane gliders, Lilienthal in 1895 built a biplane glider. He found this much easier to control and now thought he had sufficiently acquired the art of flying to justify his undertaking the next and more difficult art of imitating the rowing flight of birds. He therefore had constructed a 90-pound engine of 2 ½ horsepower, to actuate the wings of his glider, but before this motor was ready for use he was killed while making a long glide on August 9, 1896. Lilienthal gave a powerful and permanent impulse to aviation, both by his writings and by his practical experience in the air. He first showed quantitatively the advantage of arched or cambered wings and proved the effectiveness of the vertical and horizontal rudders. He was the father of the aerial glider and he had intended to undertake the problem of a power-driven flying machine at the time of his accidental death.

Sir Hiram Maxim was an Englishman who in 1893 built a gigantic airplane powered with a steam engine driving two large propellers. It was a multiplane weighing 3 ½ tons and having a span of 126 feet and a wing area of 5,500 square feet. Its propelling plant comprised a naphtha tubular boiler and a compound steam engine of 350 horsepower actuating twin screws 17 feet 10 inches in diameter. The airplane was to be steered by vertical and horizontal rudders and its lateral stability was to be secured by side planes set at a dihedral angle. The machine was mounted on a platform car running along a track half a mile in length. Above the rails of this track were guard rails to

prevent the airplane from rising more than 3 inches during the preliminary tests. Many runs along the track were made to test the working of this huge apparatus before trusting it to launch forth in free flight and during these runs the machine frequently lifted clear of the lower track and flew forward, resting against the guard rails above. Finally, on a gusty day so much lift was obtained that these holding-down rails gave way, whereupon the machine rose into the air with Maxim and his assistant, and then toppled over on the soft earth, wrecking it. Here Maxim discontinued his experiments for lack of funds after having demonstrated that a large weight can be carried in dynamic flight, but having failed to prove the feasibility of controlling an airplane in launching, in free flight, and in landing.

Prof. S. P. Langley of the Smithsonian Institution was the first person to construct an airplane possessing inherent stability. On May 6,1896, an airplane model equipped with a steam engine was successfully launched and flown, making three and a quarter turns. Tandem wings and a horizontal tail surface provided longitudinal stability, a strong wing dihedral provided lateral stability and a vertical tail surface provided a degree of directional stability. This model weighed 30 pounds, measured 16 feet in length and had a wing span of 13 feet. The engine developed between 1 and 1 ½ horsepower. As a result of this success, the Board of Ordnance and Fortifications of the War Department appropriated $50,000 to enable Langley to build a man-carrying flying machine. He first tested a gasoline driven model, having one-fourth the linear dimensions of his man-carrying machine. This model was successfully flown on August 8, 1903, and proved to be very satisfactory in all its dynamic features. Langley's man-carrying airplane was nearly a duplicate on a fourfold scale of the gasoline model. There was, accordingly, every reason to expect that, weighted and launched like the model, it would fly with the same inherent equilibrium and speed, even if left to govern itself. Having in addition a living pilot, provided with rudders for steering and balancing, together with adequate fuel for a considerable journey, it seemed to promise still better results than the model. The whole machine weighed 830 pounds, including the pilot, and had a wing area of 1,040 square feet. The gasoline, water-cooled engine weighed, without accessories, 125 pounds, and developed 52.4 horsepower in actual test at a speed of 930 revolutions per minute. Two attempts at trial flights were made with this machine, the first on September 7, 1903, and the second on December 8, 1903, but both attempts at launching were unsuccessful due to a minor defect in the launching apparatus.

Thus this carefully designed machine never had a chance, even for a moment, to exhibit its powers of sustentation and balance in normal fight. Langley now abandoned his experiments for want of funds to continue them and stowed away the machine in the Smithsonian Institution with its frame and engine still intact, the wings having been injured in the unsuccessful attempt at launching. If this machine had performed as successfully in 1903 as it actually did in 1914 after being rebuilt by the Curtiss Co., Langley would have antedated the first successful flight of the Wright brothers.

Wilbur and Orville Wright of Dayton, Ohio, attacked the problem of mechanical flight by experimenting with gliders. Their first glider was completed and successfully flown at Kitty Hawk, N. C., in the summer of 1900. In this glider, as in all their early machines, sled runners fixed under the machine were used for launching and landing.

With a wing surface of 165 square feet, they were able to glide down a slope of 10 at a speed of about 30 miles per hour. The machine was maintained in lateral stability by wing warping. The gliders used in the summer of 1901 were modeled after those of the previous year, but larger. It had a wing area of 308 square feet and weighed 108 pounds. With this glider a considerable number of glides were made, of various lengths up to 400 feet. In 1902 a third glider was constructed which was larger and showed greater efficiency than either of its predecessors, its normal angle of descent being **7** or less. With this machine some seventy glides were made and it successfully performed all the evolutions necessary for flight. The Wright brothers were now ready to apply power to a machine to drive it through the air and gain flotation by speed of motion. A power machine equipped with a 16-horsepower gasoline engine was constructed in 1903. This machine was a pusher weighing 750 pounds and possessed warping wings, a warping elevator in front, and a double rudder in rear for control purposes. On December 17, 1903, Orville Wright made the first successful man-carrying, power-driven airplane flight in the history of aviation with this machine at Kitty Hawk, N. C. Four flights were made on this eventful day, the first flight lasting 12 seconds, the next two a little more, and the fourth lasting 59 seconds and covering a distance of 852 feet.

The Wright brothers continued their experiments during the next two years with increasing success. During the season of 1904 on a field near Dayton, 105 flights were made and the first completed circle was flown. In 1905 the flights were resumed with a new machine embodying some changes dictated by experience, particularly in the method of control. On September 26, a flight of 11 miles was achieved. This was followed, within the next 9 days, by flights of 12, 15, 21, and 24 miles at a speed of about 38 miles per hour. After this the Wright brothers ceased flying for two years and the machine was dismantled to preserve secret its mode of construction till the patents could be disposed of.

The first public demonstration of a man-carrying, power flight was made by Santos-Dumont in France on August 22, 1906, flying 36 feet at a velocity of 23 miles per hour. The machine which he used was equipped with an 8-cylinder Antoinette gasoline engine developing 50 horsepower, had a wing surface of 650 square feet and weighed, including pilot, 645 pounds. In an exhibition flight on November 12 Santos-Dumont succeeded in making a flight of 723 feet, thus gaining the prize of 1,500 francs offered by the Aero Club of France for the first person who should fly 100 meters. Although Santos-Dumont was not the first to fly, he was the first airplane inventor to give his art to the world, as the general public never had any concrete idea of the machine of the Wrights until their public fights in 1908. Since Santos-Dumont's public exhibitions of the airplane in 1906, the progress of the art has been steady, rapid, and convincing.

The period from 1906 to 1914 may be called the period of the inventors in the history of aviation. The art of aircraft design and construction had little scientific or engineering basis. Stresses in flight were largely unknown and the aerodynamics of balance and control were dimly understood. The theory of stability was quite unappreciated and wing sections in use were inefficient. However, very active experimenting was being done all over the world and very important patents were being taken out. The following is a general outline of actual performance indicating the development of aviation during this period:

1907. October, Henri Farman made a public flight of 2,550 feet.

1908. September, Orville Wright made first exhibition flight of one hour duration with passenger at Fort Myer, Va.

October, Farman made first cross-country flight, Chalons to Rheims, 16 miles in 20 minutes.

December, Wilbur Wright attains an altitude of 361 feet at Le Mans, France.

1909. July, Bleriot crossed English Channel, Calais to Dover, in 37 minutes.

September, Wilbur Wright flew around Statue of Liberty.

November, Farman flew over a distance of 144 miles in 4 hours 6 minutes at an average speed of 35 miles per hour.

1910. March, Fabre made first successful flight from water at Martigues, France.

May, Curtiss made a flight from Albany to Governors Island, a distance of 135.4 miles, in 2 hours 32 minutes.

August, McCurdy received and sent messages from airplane in flight at Sheepshead Bay, N. Y.

December, Hoxey attained an altitude of 10,428 feet at Los Angeles.

1911. January, Ely alighted on and flew from deck of cruiser at San Francisco.

February, Curtiss flew from land to water alongside U. S. S. *Pennsylvania*, hoisted on board, hoisted out, and flew from water.

June, Nieuport established speed record of 82.7 miles per hour at Chalons, France.

Calbraith Rogers flew from New York to California, 4,231 miles, from September 17, 1911, to November 5, 1911, in Wright model D airplane. Longest single flight 133 miles. First transcontinental flight.

1912. Fowler flew across continent from Jacksonville, Fla., to San Francisco, Calif., a distance of 2,232 miles, in 151 days.

1913. September, Pegoud made first voluntary loop in a Bleriot.

December, Legagneux attained an altitude of 20,079 feet at St. Raphael, France.

1913. January, Sopwith produced the first small high speed military airplane. This machine was fitted with an 80-horsepower Gnome motor and had a maximum speed of 92 miles per hour.

July, Boehm flew for 24 hours 12 minutes without stopping, covering 1,350 miles, in an Albatross machine.

CHAPTER II

PRE-WAR NAVAL AVIATION

The Navy first investigated the possibilities of aviation for naval purposes in 1908 when Lieut. G. C. Sweet and Naval Constructor McIntee were detailed as observers for the test of the Wright plane at Fort Myer, Va. Lieutenant Sweet endeavored to stimulate interest in the subject of aviation and suggested the use of pontoons in this report to the Navy Department, but no action was taken thereon. In 1910, Capt. W. I. Chambers, United States Navy, who was assistant to the aid for material in the Bureau of Equipment attended the aviation meets at Belmont Park, N.Y., and at Halethorpe, near Baltimore, as an official observer. Appreciating the potential value of the airplane in naval warfare, Captain Chambers endeavored to interest the Wright Co. In arranging for a flight off of a United States man-of-war. Wilbur Wright declined to make the attempt. The Curtiss Co. was then approached and they agreed to try it. The necessary arrangements were thereupon made by Captain Chambers and on November 14, 1910, the Curtiss representative, Eugene Ely, successfully flew a 50-horsepower Curtiss land-plane from a platform hastily built on the bow of the U. S. S. *Birmingham* at Hampton Roads, Va.

Following this successful experiment, Glenn H. Curtiss, of the Curtiss Co., agreed to instruct several naval officers free of charge, as no money had as yet been appropriated by Congress for the development of naval aviation, and Lieut. T. G. Ellyson, United States Navy, was sent to the Curtiss camp at San Diego, Calif., in December, 1910. On January 18, 1911, Mr. Ely, then attached to the Curtiss camp, at San Diego, made a successful landing with an airplane on the deck of the U. S. S. *Pennsylvania* lying in San Francisco harbor, and the next day he flew this plane from the deck on which he had landed. During this same month, Glenn Curtiss and Lieutenant Ellyson perfected a hydroairplane attachment for airplanes. On January 26, 1911, Mr. Curtiss flew from the water at his San Diego base, landed alongside the U. S. S. *Pennsyl*vania, was hoisted aboard ship, subsequently hoisted out again, and flew back to his camp. This performance, together with the previous feats of Mr. Ely, gave a very decided impetus to the development of naval aviation, not only in this country but in all the leading countries of the world.

As a result of Captain Chambers's reports and recommendations on aviation, the first aviation appropriation of $25,000 was included in the 1911-12 naval appropriation act. On March 13, 1911, Captain Chambers received orders asigning him to the Bureau of Navigation, and directing him to devote his efforts exclusively to aviation and to the coordination of the aeronautical work of the various bureaus. This officer struggled with the many difficulties which always present themselves to those to whom fate assigns the difficult task of injecting new ideas and a new activity into a staid and elderly organization. The Navy as a whole was not interested and Captain Chambers worked alone and unassisted to build up a naval aviation establishment.

Early in 1911 Lieut. John Rodgers, United States Navy; Lieut. John Towers, United States Navy; and Ensign V. D. Herbster, United States Navy, were ordered to the Curtiss and Wright Cos. for instruction in the art of flying. Two Curtiss planes and one Wright plane were purchased, and in the summer of 1911 the first naval aviation unit was

organized and an aviation camp established at Greenburg Point on Government land near Annapolis, Md. In the summer of 1911 the first naval seaplane was flown off a suspended cable, Lieutenant Ellyson acting as pilot. This camp was transferred to San Diego on land adjoining the Curtiss camp during the winter of 1911-12 and moved back to Annapolis the following summer, where tent hangars were set up fronting the Severn River. The first notable flight by a naval aviator was accomplished in the autumn of 1911 by Lieut. John Rodgers, who flew from Annapolis to Washington and then to College Park, Md., from which place he later returned to Annapolis via Baltimore and Havre de Grace. Lieutenants Ellyson and Towers made a memorable record flight over the waters of Chesapeake Bay from Annapolis to Fortress Monroe, Va., and return, also in the autumn of 1911. In the next year Lieutenant Towers established a new world's endurance record for seaplanes by remaining in the air 6 hours and 20 minutes. During the year 1912, the following officers were ordered to the naval aviation camp for flying instruction: Naval Constructor H. C. Richardson to San Diego, Lieut. (Junior Grade) G. Chevalier, Lieut. (Junior Grade) P. N. L. Bellinger, Lieut. (Junior Grade) W. D. Billingsley, First Lieut. A. A. Cunningham, United States Marine Corps, and First Lieut. B. L. Smith, United States Marine Corps.

The year 1912 saw the invention of the catapult, a distinctly American achievement. The first catapult was designed at the Naval Gun Factory, Washington, D. C., under the supervision of Captain Chambers. The first shot that was attempted, with Lieutenant Ellyson as pilot of the plane, proved unsuccessful. The redesign of the catapult was assigned to Naval Constructor Richardson and Lieutenant Ellyson was successfully catapulted from this second catapult on October 12, 1912. This extraordinary feat was accomplished from a float at the Washington Navy Yard.

Another important naval aviation accomplishment which occurred in 1912 was the construction of the United States Navy Aerodynamical Laboratory at the Washington Navy Yard. This aerodynamical laboratory or wind tunnel was constructed under the supervision of Naval Constructor D. W. Taylor in order to provide a means for finding the engineering basis for the design of naval aircraft, and was the first wind tunnel of modern type to be built in the United States. It closely resembles in type the German wind tunnel at Gottingen. It is of interest to observe Naval Constructor Taylor's foresight and enterprise in providing, immediately after the purchase of the Navy's first seaplane in 1911 from the inventor, the scientific apparatus for its analysis and improvement. This wind tunnel was then, and remained for many years thereafter, the largest and most powerful in the world.

In January, 1913, the naval aviation detachment was transported by a Navy collier to Guantanamo for its first operation with the fleet. The Cuban camp was commanded by Lieutenant Towers, subject to orders from the commander in chief of the fleet. Numerous interesting and practical tests were made of the employment of planes in cooperation with ships and many of the fleet officers became more or less familiar with aviation. At this time several notable flights were made along the Cuban coast and the usefulness of aircraft as scouts in discovering the approach of a distant fleet and in detecting mine fields and submarines were amply and practically demonstrated. With the return of the fleet to the United States after the winter maneuvers, the aviation

detachment was transferred back to Annapolis again and continued under command of J. H. Towers.

In 1913 Lieut. (Junior Grade) J. D. Murray, United States Navy, Second Lieut. William McIlvaine, United States Marine Corps, First Lieutenant Cunningham, United States Marine Corps, Lieutenant (Junior Grade) Saufley, Lieut. (Junior Grade) M. L. Stolz, and Ensign W. D. Lamont joined the ranks of naval aviators. In June of this year Lieutenant Bellinger hung up a world's seaplane record for altitude by ascending to 6,200 feet in 45 minutes in a Curtiss seaplane. First Lieut. B. L. Smith, United States Marine Corps, by starting from the water, alighting on the land, and then returning to the water, made the first successful flight in an amphibian or combined land and water aircraft in the summer of 1913.

During 1912 Naval Constructor Richardson conducted a series of model basin tests on the planing properties of seaplane floats and hulls which have proved to be perhaps the most important and fruitful research ever undertaken by the Navy. Richardson for the first time showed the effect of the form of the float on its water performance, and from these tests he evolved the lines of United States Navy seaplane floats and hulls which have since that date made them a standard for others to follow. Richardson's tests showed the advantages of Vee bottom, long easy form, spray strips, and single step with sharp rise of after body. Naval Constructor J. C. Hunsaker was sent to Europe during the summer of this year to make a study of European aviation. He was then ordered to the Massachusetts Institute of Technology, where he installed a wind tunnel and where a course in aeronautical engineering was established under his supervision.

During the summer of 1913 Lieutenant Bellinger conducted experiments at Hammondsport in connection with the development of the Sperry automatic stabilizer.

In October, 1913, a Board of Aeronautics was appointed by the Secretary of the Navy to report on the needs of a suitable aeronautical organization and establishment for the Navy. Capt. W. I. Chambers was made chairman of the board and a policy of development was outlined. One of the most important recommendations of this board was for the establishment of an aviation station at Pensacola, Fla. This recommendation was approved and in January, 1914, the first United States Navy air station was established on the site of the abandoned navy yard at that place. At the same time the Annapolis aviation camp was broken up and all aviation personnel and equipment transferred to the U. S. S. *Mississippi* which was ordered to Pensacola and turned over to naval aviation in order that aviation might keep in touch with ships. Lieut. Commander Mustin was assigned to aviation and became the first commanding officer of the Pensacola air station.

In December, 1913, Captain Chambers was relieved of his duties in charge of naval aviation activities by Capt. Mark L. Bristol. This year saw the first employment of naval aviation in active service. When the Atlantic Fleet was ordered to Mexican waters in April, 1914, in connection with the occupation of Vera Cruz, a naval aviation section consisting of two airplanes completely manned and equipped was attached to the U. S. S. *Mississippi* which was sent to Vera Cruz, and another was attached to the U. S. S. *Birmingham,* which was sent to Tampico. The two airplanes at Vera Cruz were used

continually, and although these planes were not fitted for land work, for 43 days they did considerable scouting over the trenches protecting the city of Vera Cruz. To every call made upon them, the naval aviators attached to the U. S. S. *Mississippi* made ready and cheerful response and their scout work in the air was of much value in the combined Army and Navy operations at Vera Cruz. In the summer of 1914, the U. S. S. *Mississippi* was relieved by the U. S. S. *North Carolina* as the naval aviation ship, the Government having sold the former ship to Greece.

In June, 1914, the Navy Department ordered Lieutenant Towers to Hammondsport for duty in connection with the construction and proposed flight to Europe of the twin-engined seaplane *America*, with the understanding that he would be permitted to participate in that flight if success seemed feasible. The outbreak of war interrupted the project. The *America* marked the beginning of big boat development. At this point naval aviation suffered a serious setback. The war broke out and the *North Carolina* with its complement of aviation officers and men, augmented by other naval personnel, was ordered to Europe. The ship remained in Europe until the summer of 1915, performing various duties in connection with the relief of Americans there. In addition, Lieutenant Towers was ordered as assistant naval attaché, London, and Lieutenant Herbster and Lieut. B. L. Smith to Berlin and Paris, respectively, for the same duties. Work at Pensacola was brought practically to a standstill for many months.

During 1914 additional officers were assigned to aviation duty in the following sequence: Ensigns C. K. Bronson and W. A. Edwards, Lieut. Kenneth Whiting, Lieut. L. H. Maxfield, Ensigns E. O. McDonnell, Wadleigh Capehart, E. W. Spencer, H. T. Bartlett and G. D. Murray. Classes were then ordered more or less regularly until the entry of the United States in the war.

During 1915 the first Navy designed seaplane was built at the Washington Navy Yard. This plane was designed by Naval Constructor Richardson. On April 20, 1915, the Navy bought its first airship, the "D-1," from the Connecticut Aircraft Co. of New Haven, Conn. In this year Lieut. Saufley ascended to an altitude of 14,500 feet in a Curtiss seaplane and shortly afterwards made an endurance record of 8 hours and 20 minutes in the same type of plane. Another notable event of 1915 was the first catapult flight from a ship underway which was made from the U. S. S. *North Carolina* by Capt. H. C. Mustin.

In the early part of 1916, the aviation ship, the U. S. S. *North Carolina* with five planes aboard operated with the fleet during the winter maneuvers based on Guantanamo. An attempt was made in 1916 to establish a combined experimental station for the Army, the Navy, and the National Advisory Committee for Aeronautics at Langley Field, Va., but as this field was unsuitable for naval purposes because of lack of deep-water access for ships, the project was abandoned.

On March 1,1916, Captain Bristol was relieved from his duties in the Bureau of Navigation and the direction of aviation actitivities was transferred to the office of the Chief of Naval Operations where an aviation desk was placed under the aide for material. Lieut. C. K. Bronson was detailed to fill this newly created position and continued in the capacity until November, 1916, at which time his death occurred from an aviation accident. Lieutenant Towers was then assigned as assistant for aviation in the office of the Chief of Naval Operations and this officer was occupying this position when the United States declared war against Germany on April 6, 1917.

CHAPTER III

WORLD WAR NAVAL AVIATION ORGANIZATION AND PERSONNEL

When the United States entered the World War, naval aviation was under the general supervision of the aide for material, Capt. J. S. McKean, United States Navy. Lieut. J. H. Towers was on duty in the office of the aide for material as assistant for aviation, and in this capacity had direct charge of all naval aviation activities. A month after war was declared, Lieutenant Towers was relieved by Capt. Noble R. Irwin, United States Navy, who carried the load of responsibility for naval aviation during the period of hostilities, Lieutenant Towers remaining on duty as his assistant. Captain Irwin continued being assistant for aviation under the aide for material until March 7, 1918, on which date Navy General Order No. 375, creating the office of the Director of Naval Aviation, was signed by the Secretary of the Navy, and Captain Irwin was ordered to duty as the first director. This general order made the Director of Naval Aviation directly responsible to the Chief of Naval Operations.

At the outbreak of hostilities the number of trained aviators or of persons familiar in any way with naval aviation was small. The early training pilots and mechanicians had covered only the flying of aircraft, without particular attention to the requirements of aerial combat or other warlike operations. For the purposes of war, it immediately became necessary to obtain numerous trained crews composed of pilots, machine gunners, and observers, in order to operate successfully the bombs, machine guns, and radio making up the equipment of aircraft. In addition, a very large force of so-called trained ground personnel was required, and the enrollment and training of the tremendous numbers of officers and men required was in itself a task of stupendous magnitude.

The strength of the commissioned and enlisted personnel of the Navy assigned to aviation duty on April 6, 1917, and the same data as of November 11, 1918, appears in the following table:

	Apr. 6, 1917	Nov.11, 1918
Officers:		
Naval aviators	38	1, 650
Student naval aviators	0	288
Ground	0	891
Student officers (under training for commission)	0	3, 881
Total officer personnel	38	6, 716
Men:		
Aviation ratings	163	21, 951
General ratings assigned to aviation duty	0	8, 742
Total enlisted personnel	163	30 693
Total personnel	201	37, 409

The following number of officers and enlisted men were sent overseas during the period of the war:

Officers	1, 237
Enlisted men (aviation ratings)	8, 215
Enlisted men (aviation duty, miscellaneous ratings)	8, 072
Total personnel sent abroad	17,524

The total naval aviation fatalities during the World War amounted to:

	Overseas	At home
Officers	36	38
Enlisted men	86	48
Total	122	86

Only one naval aviation station--the station at Pensacola--was in existence on April 6, 1917. At the time of the armistice, November 11, 1918, the following stations and schools were in operation in the United States and Canada:

Akron, Ohio	Lighter-than-air training
Anacostia, D. C.	Experimental station.
Bay Shore, Long Island	Elementary flying school and emergency patrol station
Brunswick, Ga.	Patrol station
Cape May, N.J.	Do.
Chatham, Mass.	Do.
Coco Solo, Canal Zone	Do.
Dunwoody Institute	Ground school.
Great Lakes, Ill.	Mechanics school.
Halifax, Nova Scotia	Patrol station
Hampton Roads, Va.	Experimental and patrol station.
Key West, Fla.	Elementary flying school.
Marginal Parkway, N.Y.	Supply station.
Massachusetts Institute of Technology	Ground school.
Miami, Fla.	Elementary flying school and patrol station.
Do	Marine Corps school and flying instruction
Montauk, Long Island	Patrol station
Morehead City, N. C.	Do.
Naval Aircraft Factory	Manufacturing plant
North Sydney, Nova Scotia	Patrol station.

Pensacola, Fla.	Advanced ground and flight school
Rockaway, Long Island	Patrol station.
San Diego, Calif.	Elementary flight school
University of Washington	Ground school

The naval appropriation act of August, 1916, had made provision for a Naval Reserve Flying Corps and as soon as it became evident that the United States would enter the war in a few months certain groups of college men got together and applied for enrollment. The first group under the lead of F. Trubee Davison and consisting of 29 men was enrolled in January, 1917, and immediately began training in their own seaplanes at their own expense at Palm Beach. The second group trained at Newport News and the third at Buffalo. In each case a naval aviator was assigned to duty in general charge of the unit. The zeal and enthusiasm of the men of these groups resulted in the naval aviation having available very shortly after war was declared a nucleus of very capable young officers who proved of inestimable value in the building up of the big corps which so soon became necessary to carry out the mission of naval aviation. This nucleus was augmented by officers of the Naval Militia who were later transferred to the Naval Reserve Flying Corps and by many men taken up directly from civil life for administrative duties.

When the training of personnel was begun it was soon found necessary to divide the training into three phases, namely, ground school, elementary flight training, and advanced ground school and fight training. The first ground school was established at Massachusetts Institute of Technology in September, 1917. The aim was twofold, to give students academic instruction in aeronautical matters, and to inculcate in them the conception of strict military discipline. Additional ground schools were opened in the summer of 1918, at the University of Washington, Seattle, and at the naval training school at Dunwoody Institute, Minneapolis.

Elementary flight training was carried on at Bay Shore, Miami, Key West, and San Diego. Additional elementary schools were contemplated but the sudden conclusion of hostilities eliminated the need of them. At these elementary training stations the student flying officer was taught to fly. His instruction in a few ground school subjects was also continued. The advanced training station was located at Pensacola, Fla., and here the student naval aviators were taught gunnery, bombing, navigation, and big boat flying.

To provide officer personnel to discharge other than flying duties, it became necessary to establish a class known as ground officers, which included ordnance, communication (intelligence), navigation, aerography, and administration officers. Such ground officers were at first trained simply by the expedient of giving them the pilot's course at Massachusetts Institute of Technology and then detailing them to flight stations to become familiar with actual aviation work. More specialized training soon became necessary, however, with the result that a school for ground officers was established at the United States Naval Training Station, Great Lakes. Graduates of this school were divided into the various classifications mentioned above, according to their abilities, and

detailed in the following manner: Ordnance officers to Pensacola to take the gunnery and bombing courses, and thence for temporary duty to the Bureau of Ordnance to become familiar with the latest developments; navigation officers detailed to Pensacola to take a special course in navigation; communication officers to Hampton Roads for special instruction in communication work; administration officers to Pensacola for training in executive work and aerographers to Blue Hills Observatory, Boston, Mass., for a special course under Lieut. Commander McAdie.

For the training of aviation mechanics, elementary trade schools were established at convenient points throughout the country and an advanced training school was established at Great Lakes, Ill. Aviation mechanics who had been selected at the various elementary schools because of their special ability and qualifications were sent to the Great Lakes School for advanced instruction. This school soon became one of the largest and most successful manual training schools in the country.

Pilots for lighter-than-air craft were first sent to the same ground school as heavier-than-air pilots at Massachusetts Institute of Technology where a special lighter-than-air course was included in the curriculum. On completion of this course, all lighter-than-air students were sent to Akron, Ohio, for training in free and kite balloon work. From Akron, the students designated as dirigible pilots were sent to Pensacola and those designated as kite balloon pilots to Rockaway, Long Island, for advance instruction.

In addition to the overseas patrol stations described in other chapters of this history, home patrol stations were established at strategic points along the Atlantic seaboard from North Sydney, Nova Scotia, to Key West, Fla., and also at Coco Solo in the Canal Zone. Regular daily patrols were carried out by these stations and aircraft were detailed from these points to accompany all important convoys. During the year 1918, United States Navy airplanes flew a total of 40,883 hours on patrol duty in home waters. Patrols during the last three months of the war covered 1,305,000 nautical miles. Lighter-than-air craft patrols in home waters flew a total of 5,145 hours.

The Aircraft Production Board which was created on May 16, 1917, functioned during the war as the supreme authority with regard to aircraft production by and for the Army and Navy. The board was created by the Council of National Defense on the recommendation of the National Advisory Committee for Aeronautics. The first members were Howard Coffin, chairman; Gen. G. O. Squier, United States Army, Admiral D. W. Taylor (Construction Corps), United States Navy, Lieut. Commander J. H. Towers, S.D. Waldon, E. A. Deeds, and R. L. Montgomery. The Aircraft Production Board was transferred from the control of the Council of National Defense to the Secretary of War and the Secretary of the Navy by act of Congress (No. 48, 65th Cong.), approved October 1, 1917, which act changed the name to Aircraft Board. At the same time additional members were added from the Army and Navy. The Navy members of the enlarged board in addition to Admiral Taylor, chief constructor, were Capt. N. E. Irwin, director of naval aviation, and Lieut. Commander A. K. Atkins of the Bureau of Steam Engineering. Mr. Coffin continued as chairman of the enlarged board. The so-called aircraft scandals (based on the fall-down in the Army program) forced the resignation of Mr. Coffin as chairman in the spring of 1918 and John D. Ryan was appointed by the President as his successor. The Aircraft Board was dissolved by Executive order on March 19, 1919.

The influence of the Aircraft Board on the Navy's program of aircraft production was not very frequent or detailed, but in its larger aspects was most beneficial. The greatest single benefit to the Navy from the Aircraft Board was the resolution adopted November 6, 1917, to the effect that all air measures taken against submarines should have precedence over all other air measures. This gave the Navy priority in the War Industries Board over controlled raw materials, on the railroads for cars and trains, and in general made the Navy's task of creating a great antisubmarine fleet of flying boats possible. Another important feat of the board which was of great benefit to the Navy, was the creation and quantity production of the Liberty engine. This engine was started by E. A. Deeds of the Aircraft Board, designed by engineers selected by him, and developed by the automobile industry of the country working under the control of the Aircraft Board. Lieut. Harold Emmons, United States Naval Reserve Force (formerly of the Ford Motor Co., Detroit), was assigned to the War Department to take charge of the production of Liberty engines. The complete success of the Liberty engine was of vital assistance in making the Navy aircraft program possible as every flying boat for overseas, whether single or twin engined, was designed for the Liberty.

In the summer of 1917 the Aircraft Production Board (with the approval of the Army and the Navy) sent to Europe an expert commission to study the aeronautical situation overseas and to arrange with our Allies and our military and naval commanders abroad for the necessary design and production data for such foreign aircraft and engines as the United States should build. This commission was commonly known as the Boiling Commission. The head of the commission was R. C. Bolling (an attorney for the United States Steel Corporation), and the other members were Capt. V. E. Clark and Capt. E. S. Gorrell of the Army; Naval Constructor G. C. Westervelt and Lieut. W. S. Child of the Navy; Howard Marmon of the Nordyke-Marmon Co., and Herbert Hughes of the Packard Co. Perhaps the most important and useful accomplishment of the Bolling Commission abroad was the so-called Bolling agreement entered into with the British, French, and Italian Governments to the effect that any country had the right to produce any aircraft, aircraft engine, or accessory to be found in any other country. The compensation for any national on account of patent infringement, royalties, etc., should be made by his own government. This agreement was for the "duration of the war," and effectively stopped the activities of foreign manufacturers' agents in Washington, who swarmed about the Aircraft Board.

The Joint Technical Board on Aircraft was created by the Secretary of War and the Secretary of the Navy on May 5, 1917. The original members of this board were Maj. B. F. Foulois, Capt. V. E. Clark, and Capt. E. S. Gorrell, of the Army, and Lieut. A. K. Atkins, Lieut. J. H. Towers, and Lieut. J. C. Hunsaker (Construction Corps), of the Navy. As no official name was given to the board by its precepts and to avoid confusion with the Aircraft Production Board, and the Joint Army and Navy Airship Board, the board decided to call itself the Joint Technical Board on Aircraft upon organizing. The function of this board was to advise the War and Navy Departments on the purchase of types of aircraft and engines. A vast number of miscellaneous technical matters were also referred to the board by the War and Navy Departments and by the Aircraft Board for recommendation. The Joint Army and Navy Technical Board framed the initial aircraft

building program for the Army and Navy in May, 1917, which was approved by the War and Navy Departments for execution. The board also drew up a set of specifications entitled, "General Specifications for Building Airplanes," which was adopted by the Navy and a revision of it is still the standard practice of the Bureau of Aeronautics. On July 24, 1918, the last formal meeting of the board was held and after that date it died a natural death as the War and Navy Departments went ahead with their approved programs without further questions of technical policy.

CHAPTER IV

UNITED STATES NAVAL AIRCRAFT FACTORY

The Naval Aircraft Factory was established in order to assist in solving the problem of aircraft supply which faced the Navy Department upon the entrance of the United States into the World War. The Army's requirements for an enormous quantity of planes created a decided lack of interest among aircraft manufacturers in the Navy's requirements for a comparatively small quantity of machines and the Navy Department therefore concluded that it was necessary to build and put into production an aircraft factory to be owned by the Navy, in order, first, to assure a part at least of its aircraft supply; second, to obtain cost data for the department's guidance in its dealings with private manufacturers; and third, to have under its own control a factory capable of producing experimental work.

In June, 1917, therefore, the Navy Department directed Lieut. Commander Coburn of the Construction Corps to make a survey of the situation and to make a report upon a suitable location, size, and cost of a naval aircraft factory which would be capable of producing 1,000 training seaplanes a year or their equivalent, including in this report the minimum time in which such a plant could be built and put into operation. As a result of these instructions, Commander Coburn visited all private plants in the country and made a detailed study of the Churchill Street plant of the Curtiss Co. in Buffalo which was then the only factory in the country that could be considered a quantity producing plant for airplanes. There was no time to make an exhaustive study of the problem such as would be expected under ordinary peace-time conditions before embarking on an enterprise of this magnitude, consequently about the middle of July Commander Coburn submitted his report. He recommended the use of vacant land in the Philadelphia Navy Yard as a site and the construction of a main building for the factory proper and of three auxiliary buildings for a dry kiln, dry lumber storehouse, and boiler house. He estimated the cost of this construction at approximately $1,000,000 and the minimum time required to put the factory into operation at 100 days.

On July 27, 1917, the Secretary of the Navy approved the project, the contract was let on August 6, and ground broken four days later. The first power-driven machinery was put in operation on October 16, and the entire plant was completed by November 28, 1917, 110 days after breaking ground. Commander Cobum (Construction Corps), United States Navy, was detailed as the first manager of the Naval Aircraft Factory and reported at the Philadelphia Navy Yard for this duty on August 27, 1917.

It was contemplated that the factory when completed should build training planes but by October the training-plane program was well in hand in other airplane factories and the greatest need was then for patrol planes to be used in antisubmarine warfare, so the Naval Aircraft Factory was put into production with the H-16 patrol flying boat. Plans and engineering data for this type of machine were received by the factory October 26, 1917. On March 27, 1918, just 228 days after ground was broken and 151 days from the receipt of drawings, the first H-16 built by the factory was successfully flown and on

April 2, 1918, the first and second factory built H-16 flying boats were shipped to Killingholme, England.

The main building of the original plant was 400 feet square and contained a balanced air-plane factory—that is, mill, metal shop, panel shop, covering, varnish, and dope rooms, hull shop, and final assembly—together with the general offices, toilet, and locker rooms, cafeterias, and storeroom. In addition there was in the original plant a 4-cell Tiemann dry kiln, a brick building 60 by 100 feet, heated, for the storage of kiln-dried lumber, a lumberyard for the accommodation of approximately 3,000,000 feet of lumber and a boiler house.

In December, 1917, the Navy Department practically quadrupled its flying-boat program to take care of additional responsibilities that the Navy had assumed for patrol and convoy work in European waters. At this time the Naval Aircraft Factory was not yet in production, but the original plant was complete and a satisfactory, hard-working organization had been created. This new program necessitated the provision of additional manufacturing facilities and as the Army was not prepared to release any of the facilities assigned to it by the Aircraft Board, the only solution was to expand the Naval Aircraft Factory. The question then arose as to whether or not to construct a balanced factory to supply this needed capacity. After considerable discussion the conclusion was reached that the time required for the erection of such a building, the assembling of sufficient personnel, etc., was so great as to preclude so doing. It seemed better to utilize idle plants in the industrial world for the production of parts and to erect as an enlargement of the factory an assembling plant to be fed by these sources of parts and minor assemblies. It was decided therefore to build a main assembly building, 1,100 by 350 feet, a 6-story storehouse, a 3-story office building, a hangar, and additional dry kilns and boiler capacity as an extension to the factory. This extension was approved by the Aircraft Board on January 25, 1918, and by the Secretary of the Navy on February 9, 1918. The cost of this extension to the original plant was approximately $3,750,000. The enlarged plant got into production on July 6, 1918.

As sources for hulls seven small yacht building yards were obtained, and for the supply of wings, metal parts, tanks, engine foundation assemblies, tail surfaces, etc., the services of about a dozen plants were enlisted which would have otherwise stood partly idle due to the large decrease of their peace-time business. These plants included the Victor Talking Machine Co., the Singer Sewing Machine Co., and a number of furniture, automobile body, and sheet-metal products factories. The productive capacity of these outside plants was placed directly under the control of the manager of the Naval Aircraft Factory who maintained a branch office in each and directed them as if they were departments of the factory proper. This novel manufacturing procedure proved highly successful.

More difficult than the task of providing the plant and its equipment was that of assembling the working force and its directing personnel. The aircraft manufacturing industry was in its infancy and men skilled in aircraft construction were not to be had. The first mechanic was employed on October 1, 1917. At the time of the armistice the entire force numbered 3,642 persons and at no time during the war were there ever as many as 25 employees who had previously worked on the construction of aircraft. Most

of the employees including superintendents, engineers, inspectors, and foremen, had to be trained to their work. Special effort was made to train and utilize women employees during the war as this was considered a war duty, the maximum number reached being about 900.

The Naval Aircraft Factory was initially put in production on the Curtiss H-16 drawings. These drawings were not suitable for progressive assembly manufactured by concerns unfamiliar with aircraft. The Curtiss Co.'s experienced foremen and workmen did not need absolutely clear and complete drawings of every minor part. Also many parts were cut to fit during final assembly. But for the Naval Aircraft Factory work, for example, the men and women of the Victor Talking Machine Co. had to make parts whose use to them was a mystery and, furthermore, must make them to fit with parts from some furniture maker in Philadelphia who had never seen a flying boat. It therefore became necessary to redraw, redetail, and standarize the H-16 drawings so that part makers could work independently. The H-16 as thus revised was designated C-1. This work of standardization was carefully and thoroughly done by Mr. George R. Wadsworth.

In the spring of 1918, advices from our naval aviation forces overseas indicated that the British experimental air station at Felixstone had developed a new type of patrol flying boat called the F-5 which was a great improvement over the Curtiss H-16 both as to seaworthiness and bomb-carrying capacity. This presented the problem of whether or not to stop the production of H-16's and change to F-5's. Such a change would mean a long interruption of delivery as the H-16 was by this time in rapid standardized production. However, it also appeared about this time that larger bombs than the H-16 could carry were required to sink German submarines and that the F-5 could carry them. The end of the war was not in sight and looking toward 1919, the decision was made to switch production to F-5's as rapidly as possible without stopping the delivery of H-16's.

The British Admiralty, at the request of Admiral Sims, furnished the Navy Department with the drawings of the F-5. These drawings were a great disappointment and were entirely impossible for quantity manufacture. They required hand cutting and fitting by experienced airplane workers and also materials we did not have in quantity.

The labor of converting H-16 plans to C-1 standard plans was slight compared with the labor involved in the complete redesign of the F-5, preserving external dimensions of course. All metal parts had to be redesigned for machine fabrication by our methods. The hull in particular was considered weak by Commanders Richardson and Hunsaker and the former completely redesigned it on a longitudinal framing system, preserving the outer lines only. The engine installation was designed for Rolls-Royce engines in the British boat and it had to be redesigned to take Libertys. Thus the American F-5-L was created which resembled its British prototype only in essentials.

The output of the Naval Aircraft Factory to November 11, 1918, included 183 twin-engine patrol flying boats, with 50 sets of spares, valued at $5,435,000. Of these 183 boats, the last 33 were F-5-L's. A rate of production of one plane per day was reached in June, 1918. On September 30, 1918, the activity of the factory is summarized by the following data:

Floor space, square feet	900,000
Ground covered, including lumberyard, acres	41
Employees in subcontractors' works	7, 000
Employees at Naval Aircraft Factory	3, 600
Pay roll for September, 1918	$405,000
Value of plant	$4,476,000
Supplies in store	$1, 621,000
Work in process	$1,662,000
Total inventory	$7,759,000
Total expended in wages up to Oct. 1, 1918	$2, 790, 000

After the armistice the factory's orders were canceled and experimental work authorized. The working force was reduced from 3,600 to 1,100 and the floor space used in manufacturing to 250,000 square feet. The great assembly building was turned into a storehouse for excess aircraft material and the original building' first built in 1917 became the factory proper. On December 7, 1920, excess aircraft material to the value of $40,500,000 which had been returned from overseas was stored at the Naval Aircraft Factory.

During the year 1919 the factory was engaged in the manufacture of NC, Vought, and Loening type planes and cars for nonrigid airships. The principal work was, however, the overhauling and reconditioning of service aircraft. The extent of this work in 1919 was the overhaul and issue to service of 40 F-5-L, 10 HS, 24 R-6, 24 DH, and 40 of miscellaneous types. Expenditures at the Naval Aircraft Factory in the fiscal year 1919-20 were $2,000,000, not counting material drawn from store already paid for during the war.

In succeeding years the development of new types of aircraft, catapults, and miscellaneous apparatus has absorbed the capacity of the factory, together with the regular overhaul and repair work.

During the years 1921 and 1922 the large assembly building was gradually cleared of aircraft in storage and fabrication of girders and parts for the U. S. S. *Shenandoah* took place in this space. It is of interest to note that the bold theory of manufacture adopted during the war in building H-16's by progressive assembly of parts was followed in building the *Shenandoah.* The subassemblies built at the factory were trucked to Lakehurst and erected into an airship. The parts fitted perfectly and no manufacturing plant at Lakehurst was needed.

In line with the principal purpose of the Naval Aircraft Factory, namely, the experimental development of aircraft and their accessories, the aeronautical engine testing laboratory was transferred from the navy yard, Washington, to the Naval Aircraft Factory in Philadelphia in January, 1924. This laboratory as installed at the Naval Aircraft Factory includes 4 test stands, 10 dynamometer rooms, store and tool room, overhaul and machine shops, photo and examination room, accessories and instrument laboratories, and drafting room. Thus the bureau's experimental work for both power plants and for aircraft structures is now coordinated under one head.

In conclusion, it may be stated that the Naval Aircraft Factory represents one of the most important and vital functions of naval aeronautics. It is a first-class industrial establishment, capable of doing any kind of aeronautical work which may be required by the bureau. However, in accordance with the bureau's policy to encourage private aircraft manufacture, the work of the factory has been restricted to experimental work, repair and overhaul for the service, and the general storehouse for naval aviation activities.

CHAPTER V

UNITED STATES NAVAL AVIATION IN FRANCE

In May, 1917, at the request of the French Government, the Navy Department decided to send a naval aviation force to France. The first unit to be organized was the First Aeronautic Detachment, United States Navy, which was assembled for training at Pensacola and consisted of 7 officers and 122 men under the command of Lieut. Kenneth Whiting, United States Navy. The detachment sailed for France during the latter part of May aboard the two colliers, U. S. S. *Jupiter* and U. S. S. *Neptune*. The *Jupiter* left the States on May 23 and arrived at Bordeaux on June 7, while the *Neptune* left two days later and arrived at St. Nazaire on June 8. This detachment was the beginning of the United States naval aviation forces, foreign service, and was the first military or naval unit to land in Europe for service ashore. Lieutenant Whiting immediately proceeded to Paris and held a conference with Admiral Le Bon, French Minister of Marine, and Capitaine de Vaisseau Cazenau, chief of the French Naval Air Service. At this conference it was decided to send a mission consisting of French and American officers to make an inspection of the French coast for the purpose of locating sites for United States Navy air stations. Capitaine de Fregate Laborde, Lieutenant Whiting, Paymaster Conger, and Captain Smith, the latter assistant to the United States naval attache, were appointed members of this board, and after a careful inspection of the French coast, which was completed about the 1st of July, submitted their recommendations in the form of a report. This formed the basis of an agreement between Lieutenant Whiting and the French Minister of Marine, which was forwarded to the Navy Department for approval. In the meantime all pilots of the First Aeronautical Detachment, United States Navy, were sent to the French training school at Tours and all mechanics of the detachment to the French school for mechanics at St. Raphael.

On September 16, 1917, the Navy Department authorized the establishment of 11 naval air stations in France, namely, Dunkerque, L'Aber Vrach, Brest, Ile Tudy Le Croisic, Paimboeuf, Fromentine, Rochefort, St. Trojan, Moutchic, Pauillac. Three of the stations, Dunkerque, Paimboeuf, and Moutchic were simply to be taken over from the French, while the remainder were to be constructed as fast as materials could be obtained from the United States. At the same time, the Navy Department ordered Capt. H. I. Cone, United States Navy, to Paris to assume command of all naval aviation activities in Europe and direct command of all activities in France as commander, United States naval aviation forces, foreign service under the direction of Vice Admiral Sims, United States Navy. Captain Cone relieved Lieutenant Whiting on September 29, 1917, and remained in direct command of United States naval aviation forces in France until August 1, 1918, when he moved his headquarters from Paris to London and became a member of Admiral Sims' staff. The naval aviation forces in France were placed under the command of Rear Admiral H. B. Wilson, commander United States naval forces in France on August 1 and Capt. T. T. Craven as aide for aviation on the staff of Admiral Wilson was directly charged with all aviation matters in France thereafter until the end of the war.

In addition to the stations previously mentioned the Navy Department shortly

afterwards also authorized United States naval air stations at Trequier, Guipavas, La Trinite-sur-Mer, La Pallice, Gujan, and Arcachon. When the northern bombing group was organized this unit took over the seaplane site at Dunkirk. The property at Rochefort, ceded to the United States Navy for a dirigible station, was given back to the French government at its request in order to make room for dirigible hangars and workshops that were moved out of Paris by reason of the German offensive in March, 1918. The American station at this point was therefore abandoned. Hence there were 15 stations in operation or under construction attached to the French unit of United States naval air stations at the time of the armistice. These stations together with their complement on November 11, 1918, were as follows:

	Number of officers Nov. 11, 1915	Number of men Nov. 11, 1918		Number of officers Nov. 11, 1918	Number of men Nov. 11, 1918
Air stations operating:			Air stations operating-Con.		
Trequier	25	202	Montchic	93	485
L'Aber Vrack	53	455	Arcachon	19	318
Brest	188	771	Air stations under construc tion:		
IIe Tudy	32	357	Guipavas	25	196
La Trinite	10	148	Gujan	15	252
Le Croisic	42	337	La Pallice	7	169
Paimboeuf	43	478			
Tromentine	38	356	Total	850	6,174
St. Trojan	40	345			
Pauillac	220	1,305			

The United States naval air station, Trequier, was located between the towns of Trequier and Plougiel about 4 miles from the coast at the junction of the Guindy and Jaudy Rivers, which form the Trequier River at this point. The purpose of this station was to provide aerial patrols into the English Channel, connecting up with the sectors covered by the French seaplane stations east of the Cherbourg Peninsula, and on the northwest with the L'Aber Vrach sector. Lieut. A. M. Baldwin, United States Naval Reserve Force assumed command of the Trequier station on August 14, 1918, and remained in command until the station was demobilized. The first aircraft, consisting of several HS-1 planes, arrived at the station on September 24, 1918.

The United States naval air station, L'Aber Vrach, was situated on the rocky island of Ehre in the harbor of Vrach. The station was one and a half miles south of the large Ile Vierge Light-house which marks the southern entrance to the English Channel and 21 miles north of Brest. The patrol area of this station extended over the English Channel to the sectors patrolled by the Irish bases. The first construction work was commenced about February 1, 1918. The first commanding officer was Gunner C. A. McKelvy, United States Navy, who took command on January 24, 1918, and he was relieved on April 26 by Lieut. H. B. Cecil, United States Navy. On July 18, 1918, the first airplane arrived at the station. By September 2, 10 planes, all HS flying boats, were on

hand and from that time on regular patrol flights were made and escorts furnished to convoys.

The United States naval air station, Brest, was located in the western extremity of the French navy yard and consisted of both a seaplane base and a kite balloon station. Lieut. (J. G.) G. R. Romulus, United States Navy, arrived at Brest on October 7, 1917, for the purpose of establishing this station. The first seaplane pilot to report on the station was Lieut. Commander F. C. Dichman, United States Navy, who arrived on February 13, 1918, and relieved Lieutenant Romulus as the commanding officer. On June 6, Lieut. Commander Dichman was detached and Lieut. W. M. Corry, United States Navy, reported and assumed command. The only fatal accident at this station occurred on August 21, 1918, when an HS-1 seaplane, piloted by Ensign R. F. Clark, United States Naval Reserve Force, with Ensign A. L. Boorse, United States Naval Reserve Force, and W. F. Rodman, machinist mate, second class (A), United States Navy, as observers crashed from a height of 400 feet resulting in the death of the entire crew. The first kite balloon detachment for this station consisting of 2 officers and 40 men arrived there on July 4, 1918, and a few weeks later kite balloon operations in connection with destroyers were commenced which continued until the armistice. The types of balloons used were the Goodrich Types M and R.

La Trinite-sur-Mer was a kite balloon station for the supply of kite balloons to patrol vessels covering the sector from the Bay of Quiberon down to La Pallice. It was situated at the small fishing village of La Trinite-sur-Mer on an inlet in the Bay of Morbihan, 6 miles distant from La Trinite, the nearest railroad station. Construction of this station was begun about the middle of March, 1918, and was ready for operations two months before the cessation of hostilities. The first kite balloon did not arrive at the station, however, until October 18 and it was the 8th of November before the second balloon arrived. Hence this station had very little opportunity to participate in active war operations.

Le Croisic was the first United States naval air station to be organized in France. It was also the first completed and the first to operate. The station was located on two small islands called, Les Petit et Grand Joncheres. These islands previously had been used by fishermen as a place to dry their nets and were a part of the village of Le Croisic, situated on the Baie do Croisic, about 18 miles from St. Nazaire. The principal object in having a station at Le Croisic was to provide aerial escorts for the troop convoys coming into the Loire River. It was a common saying among the American Expeditionary Forces arriving overseas that one of the most welcome sights on their voyage across was a flying boat from Le Croisic soaring overhead and that they felt absolutely secure, once they were met by the aerial escort. The building of the station was started on July 26, 1917, and on October 6,1917, the first airplanes for this station were received. These were French seaplanes of the Tellier type. On November 13, 1917, the first patrol flight was made and from that date to the armistice, patrol and convoy flights were made regularly, weather permitting. During this entire period there was but one fatal airplane crash. This crash occurred on July 1, 1918, when T. M. Weddell, pilot, and E. C. Kneip, observer, were killed as a result of the collapse of one wing of their plane causing the machine to fall in a nose dive.

Paimboeuf was a dirigible station which was originally constructed and operated by the French and was transferred to the United States Navy for manning and operation on March 1, 1918. The station was located near the city of Paimboeuf and its purpose was to supplement the patrols and escorts in the vicinity of the mouth of the Loire River and to give protection to troop ships. One dirigible, the *Astra Torres (AT-1),* was turned over to the Americans at the same time that the station was transferred and a second dirigible, the *Zodiac Vedette (VZ-3),* was obtained from the French on March 20. Three other dirigibles were obtained from the French Navy, the *VZ-7* on June 8, the *AT-13* on August 30, and the *VZ-13* on the 25th of October. The *AT-1* and the *VZ-3* became unserviceable for further patrol work in September, 1918, and the former was deflated and sent to the United States while the latter was returned to the French Navy at Rochefort. This left three dirigibles in commission at the time of the armistice. Upon completion of demobilization on January 26, 1919, the station reverted back to the French Navy.

The United States naval air station, Fromentine, was located at the southern end of the island of Fromentine in the Province of Vendee. The island was about 12 miles long and separated from the mainland by a half mile stretch of water. The sheltered water between the island and the mainland made this an ideal location for a seaplane station. The village of Fromentine was situated on the mainland and there was no town of any importance within 40 miles of the station site.

Construction work at this station began on February 23, 1918, and continued until October 26. The entire work of construction was done by United States naval personnel using nothing but American materials. The first commanding officer was Gunner (R) R. J. McGee, United States Navy, who arrived at Fromentine on February 4, 1918. He was relieved on March 13 by Lieut. Commander W. G. Child, United States Navy. The third and last commanding officer was Lieut. Commander W. Capehart who relieved Lieut. Commander Child on April 26.

On June 29, two *HS-1* seaplanes were delivered at this station from Pauillac and by the end of July, eight planes had been received. The first of 200 convoy flights from this station was made on August 17, and thereafter all convoys were escorted through the area assigned to this station by planes. This area was also covered by regular patrol flights and an "alert section" was at all times ready to respond within three minutes to any "allo" signal received.

The La Pallice station was never commissioned as it was still under construction at the time of the armistice. It was to be a kite-balloon station for the purpose of furnishing kite balloons to patrol vessels engaged in escort work from La Pallice to Bayonne, near the Spanish border. The station site was located near La Rochelle, one of the largest ports on the west coast of France. As this site was originally a field of uncut wheat and, as the ground for the station had been requisitioned by the French Government from civilian inhabitants, it was necessary to delay the starting of construction until June 23, 1918, in order to allow the former owners to remove their property. The building of the station was also seriously hampered by the nonreceipt of

materials. The first detachment of United States Navy personnel, consisting of 4 officers and 32 enlisted men arrived at the station on June 5.

The United States naval air station, St. Trojan, was beautifully situated on the Straits of La Maumusson, which separates the southern end of Ile d'Oleron from the mainland near the town of that name. The whole setting of the station and its vicinity was so quiet and beautiful that it made one think of a small seaside resort rather than of a war-making establishment. St. Trojan was established for the protection of vessels entering the mouth of the Gironde River. The contract for the construction of the station was let to a French contractor for 1,200,000 francs. The plans called for 20 buildings and the date for the completion of the station was set for June 16, 1918. The seawall and the hangar foundations were started in January, 1918, and although not actually completed, construction work was sufficiently far advanced by the middle of June to permit the beginning of aircraft operations at that time. The first two sea-planes arrived at St. Trojan on June 29, 1918. These were French planes, manufactured by the Levy-le-Pen Co. and equipped with the 280-horsepower Renault motor. The first convoy flight was made from this station on July 19, and convoy and patrol flights were made regularly thereafter. The first and only fatal accident at this station occurred on August 20, when a seaplane was blown up on the slipway while about to leave for a patrol flight. Eight men were killed and 16 injured as a result of this accident, which was caused by a defective bomb-carrying gear. On November 13, 1918, demobilization began and the station went out of commission on January 19, 1919.

The United States naval air station, Arcachon, was located on the Bassin d'Arcachon on the eastern side of Cape Ferret and about 3 miles from the southern end of the point of the cape. The site consisted chiefly of sand dunes, covered with pines, and of low areas subject to inundation at high tide. A contract was made in the autumn of 1917 by the French Navy, acting on behalf of the United States Navy, for the construction of this station and on November 5, 1917, ground was broken by the French contractor, M. Hauret. French methods were employed and fair progress was made for about three months and then difficulties arose due to labor strikes and shortage of materials which considerably delayed the work of construction. The station was placed in commission on June 8, 1918, but the first planes did not arrive on the station before the middle of August. Regular convoy and patrol flights were started on September 14, 1918. The commanding officer of the Arcachon station was Lieut. Zeno W. Wicks, United States Navy.

The United States naval air station, Gujan, was also located on the flat sandy shores of the Bassin d'Arcachon. It was designed to be a dirigible station but never progressed beyond the constructional phase. Construction work was started in February, 1918, but very little progress was made before the signing of the armistice, due to lack of men and material.

Guipavas was a dirigible station located near the town of that name in the Province of Finistere. The construction of the station still remained uncompleted on November 11, 1918, the date of the cessation of hostilities, and the station never actually operated. The first United States Navy personnel arrived at this station on March 10, 1918, and although construction work was begun immediately thereafter, an

insufficient number of men and lack of material prevented completion of same before the armistice.

The training station for the French coastal unit, United States naval aviation, was located at Moutchic on the north shore of Lake Lacanau, 4 miles from the ocean and 32 miles from Bordeaux. At this station there was carried on instruction and review work in aerial fire, navigation, aerial photography, ordnance, bomb dropping, and intelligence work. Pilots trained in the United States were usually sent to the Moutchic station for a finishing course under actual war conditions before being placed in active service. The first commanding officer was Lieutenant (J. G.) Callan, United States Naval Reserve Force, who assumed command on July 17, 1917. The other commanding officer was Lieut. G. C. Dickman, United States Navy. Operations were begun on September 27, 1917, when Ensign R. A. Lovett, United States Naval Reserve Force, made the first flight in seaplane FBA No. 295. Many other trial flights were made in FBA's on the days following, but there was no routine flying or aerial instruction until October 24, 1917. On this date classes were organized in navigation, gunnery, signaling, airplanes, motors, and Navy regulations, including both ground school and flying instruction. Courses in bombing and in intelligence work were later added to the curriculum of the school. At the time of the armistice, the station was thoroughly organized and equipped with 23 permanent officers, 34 officers under instruction, and 493 enlisted men. There were 24 planes on the station, 11 of which were H-1's while the remainder were French Donnet-Donkaut and Tellier planes.

At the United States naval air station, Pauillac, France, were the receiving barracks, the assembly and repair plant, and the supply depot for the French coastal unit of United States naval aviation. It was to Pauillac where personnel and supplies were sent upon their arrival overseas for distribution among the various air stations and where all planes and motors were sent for repair and overhaul. Pauillac was selected for this work on account of its central location, its rail connections, the deep-water dock immediately adjoining, the climate, and the amount of suitable ground available. In less than a year, a complete factory town with sawmills, sail-lofts, machine shops, warehouses, hospitals, barracks, garages, and a movie theater sprang up where before were nothing but cow pastures, vineyards, and an old Roman graveyard. To see the 7,000 bluejackets bustling about their work, yard engines puffing and freight cars loaded with incoming and outgoing material, and to hear the hum of the motors being tested and the whirr and buzz of machinery, made one think of a busy navy yard in the United States. The first United States Navy personnel arrived at this station on November 27, 1917, and the station was placed in commission on December 1, 1917. The first shipment of Liberty motors from the United States was received on April 23, 1918, and the first shipment of planes from the United States on May 25. The first official flight of an American plane in France, an HS-1 flying boat, was made at Paulliac on June 13. The commanding officer of the station at the time of the armistice was Capt. Frank T. Evans, United States Navy.

The first American patrol of the French coastal unit of United States naval aviation was made at Le Croisic on November 13, 1917, and the last at Brest on December 13, 1918, when the presidential convoy was met and escorted by American planes and dirigibles. The French coastal unit operating for an effective period of 9

months sighted 27 submarines, attacked 25, damaged 12, and probably sank 4. In addition the United States airplane stations in France discovered and destroyed a large number of drifting mines. Escorts to convoys were provided and scout patrols were maintained as a matter of regular routine, and whenever a submarine was reported in the patrol area of a United States naval air station during hours and weather fit for flying, an alert section of planes was sent in search of the submarine.

CHAPTER VI

UNITED STATES NAVAL AVIATION IN THE BRITISH ISLES

United States naval aviation operations in the British Isles were carried on by 7 stations, 2 in England and 5 in Ireland. The two English stations were located at Killingholme and Eastleigh. Killingholme was a patrol station which was placed in commission on June 30, 1918 by Lieut. Commander Whiting who remained in command of the station until the end of the war. This station was intended primarily for the purpose of conducting offensive operations in Heligoland Bight, but due to the limited fuel-carrying capacity of machines available at that time, patrols of this area were not feasible, and pending the construction of machines capable of this duty, shorter patrols and convoy operations were carried on. From June 30 until the signing of the armistice, the Killingholme patrol station convoyed 6,243 allied vessels and covered approximately 60,000 miles upon 233 patrols. During this time many of the Killingholme pilots were also loaned to the British forces and were everywhere praised in the highest terms. The casualties at this station were two officers and seven men. Of the 10 attacks on enemy submarines made by the Killingholme station, 4 brought definite results. In two cases, on July 9 and August 7, a verdict was returned from the Admiralty of "probably seriously damaged." On July 25 a submarine was "possibly slightly damaged" and on July 19 a submarine, the U. B. No. 110, was attacked, which was sunk later in the day by surface craft. The planes used at Killingholme were mostly H-16 flying boats. At the time of the armistice 91 officers and 1,324 men were attached to the Killingholme station.

The Eastleigh station was used for the reception, assembly, and overhaul of planes for the northern bombing group. For this purpose it was splendidly located, as it was only 4 miles from the port of Southampton, had good rail connections, and was within flying distance of the aerodromes of the northern bombing squadrons across the channel. It was originally designed and built for a reception park for the Royal Air Force and was transferred to the United States naval forces about the middle of June, 1918. This station also served as a supply depot for both Killingholme and the northern bombing group.

The Irish stations were located at Queenstown, Wexford, Lough Foyle, Whiddy Island, and Berehaven and were organized as a unit under the command of the commander, United States naval air stations, Ireland. Commander F. McCrary, United States Navy, assumed command of the United States naval air stations, Ireland, on February 14, 1918, and remained in command throughout the war with headquarters at Queenstown. The sites for these stations were selected at the request of the British Admiralty and in accordance with their plan of operation against submarines. In March, 1918, construction under the supervision of United States Navy civil engineers was commenced. All stations were completed at practically the same time about the middle of September and operations began immediately.

The station at Queenstown was located on the southwestern section of Queenstown Bay. In addition to being a patrol station, it was also an assembly, repair, and supply depot as well as the headquarters of the commander of United States naval air

stations in Ireland. This station supplied patrols and convoys from Cape Clear on the west, south into the English Channel to the sector covered by the aerial patrols from the north coast of France, and southeast and east to the sectors covered by the stations in the southwest of England and at Wexford.

The station at Wexford was located on the eastern shore of a wide shallow bay at the southeastern corner of Ireland. Its purpose was to provide convoys and patrols in the sector to the east of Queenstown.

The station at Lough Foyle was located on a long narrow arm of the sea on the north coast of Ireland about 6 miles north of the town of Londenderry. This station patrolled the waters in the vicinity of the northern outlet to the Irish Sea.

The Whiddy Island station was located on the eastern side of the island of that name in Bantry Bay. Patrols and convoys for the waters to the southwest of Ireland were furnished by this station.

Berehaven was a kite-balloon station where balloons were kept for use in conjunction with torpedo-boat destroyers. The balloons were transferred from the shore to the destroyers, made fast, and towed at an altitude of about 500 feet. This station was located on a beautiful sound formed within Bantry Bay behind Bere Island near Castletown.

The following is a summary of operations of the United States naval air stations, Ireland:

Total number of flying hours, 761 hours 24 minutes.
Distance covered, 45,683 miles.
Oil patches sighted, 5.
Oil patches bombed, 3.
Submarines sighted, 7
Submarines bombed, 7.

Two of the submarines bombed were officially credited with having been damaged to such an extent that they had to return to their base. One of these submarines was preparing to attack a large convoy of troop ships. This was a very creditable performance when the facts are taken into consideration that for a large part of the time each station had only two seaplanes in operation and never more than four, that pilots had to be trained, and that the weather conditions are exceptionally bad all around the Irish coast.

CHAPTER VII

UNITED STATES NAVAL AVIATION IN ITALY

In the latter part of November, 1917, the Italian Government requested that the United States naval aviation activities be extended to Italy, offering to completely equip the stations if the United States would man and operate them. It was accordingly agreed that the Italian naval air stations at Bolsena, Porto Corsini, and Pescara should be taken over by the United States. Bolsena was a training station situated on the Lake of Bolsena about 60 miles northeast of Rome. The Porto Corsini station was located on the Adriatic Sea near the town of Ravenna and the Pescara station was also on the Adriatic near the town of Pescara. The objective of these two stations was the Austrian naval base at Pola. The original Italian request for aid was made at Washington by the Italian naval attache and the resulting agreement as to the nature of this aid was drawn up in Rome by Lieut. J. L. Callan, United States Naval Reserve Force attached to United States naval aviation headquarters, Paris, and Captain De Filippi, head of Italian naval aviation. This agreement was approved by the two Governments in February, 1918.

On February 19, 1918 the first American aviation detachment to enter Italy arrived at Bolsena.. Two days later the Bolsena training station was officially put in commission as a United States naval air station, Lieutenant Calderara of the Italian Navy transferring the command to Ensign W. B. Atwater, United States Naval Reserve Force. Actual instruction of students was started at once. The first flying instructors were Italians but they gave way to American instructors as soon as the latter had become proficient in handling Italian planes. At the beginning F. B. A. flying boats were used exclusively for instruction purposes but later some Macchi L-3 and M-5 boats arrived and thereafter training in these two types was also given. One S. V. A. seaplane was sent to the school but it did not prove satisfactory. Ground school work was also organized and instruction was given in theory of flight, navigation, engines, Navy Regulations, the Bluejackets Manual, and signals. The only casualty at the Bolsena training station during its nine months of operation occurred on March 20, 1918 when Clarence A. Nelson, machinist mate first class (A), United States Navy was killed while making his first solo flight. In his memory, the town of Bolsena named the road leading from the town to the hangars, Via Nelson. The total number of officers and men who underwent instruction at the Bolsena training station was 134. Upon completing the course of instruction, pilots were sent to combatant air stations in either Italy or France. Statistics of the Bolsena station as to the number of machines and amount of flying done are as follows: Greatest number of machines, 18; number of flights, 5,540; actual flying time, 2,216 hours 9 minutes.

On July 23, 1918 the first American aviation personnel arrived at Porto Corsini. This personnel consisted of a detachment of 377 officers and men from Pauillac, France, under the command of Lient. W. B. Haviland, United States Naval Reserve Force. The following day Lieutenant Haviland took over the Porto Corsini station from the Italians and placed it in commission as a United States naval air station. The Austrians were

apparently aware of the arrival of Americans at Porto Corsini and decided to give them a proper reception; for on July 25 a squadron of enemy planes flew over the camp at midnight and dropped bombs. Luckily, however, they made a mistake as to the location of the station, and although two large bombs landed within 500 yards of the camp, making holes eight meters in diameter, and from four to five meters deep, the majority of bombs landed in the marshes and canals further up the coast.

In addition to routine patrols of the Adriatic Sea, the United States naval air station, Porto Corsini, carried out offensive bombing operations against the enemy base at Pola. All operations were conducted under the direction of the Italian naval aviation district commander at Venice. The first air raid upon Pola was made on August 21 with one M-8 and four M-5's for the purpose of dropping propaganda matter. Besides antiaircraft fire, five Austrian land pursuit planes were encountered at Pola and the Americans immediately attacked them. One enemy plane was shot down by Ensign Ludlow and the others then returned to their base. No American pilot suffered any injuries as a result of the engagement. Telegrams were sent from the Italian district commander and the commander United States aviation forces in Italy commending the pilots for their brilliant work. On the following night the enemy made an air raid in reprisal and although one of the buildings of the Italian naval station in the vicinity of the air station was wrecked by a bomb, there were fortunately no casualties.

On the nights of August 22, 24, and 29 our forces made return air raids upon Pola, dropping a considerable number of bombs upon the arsenal. On September 1, in compliance with orders from the local Italian naval commander, a successful search patrol was made for an Italian submarine. On October 7, six Macchi 5's left the station at 7 a.m. for a reconnaissance patrol and observation flight. Observations were commenced over Pola at 8.20 a.m. and two complete circles were made over the harbor. The planes were attacked by antiaircraft guns and three enemy seaplanes and two land planes took the air but they did not oppose the operation of our machines. All machines returned safely to Porto Corsini at 9 a.m. On October 22, three M-8's, two F. B. A.'s, and eight M-5's left in the afternoon for a bombing offensive against Pola in conjunction with the Italian Venice squadron. It is note-worthy that 13 out of the total of 43 planes taking part in this operation were from Porto Corsini, although there were then only 16 planes at the Porto Corsini station. The barrage put up by the Austrians was very poor, causing little inconvenience, and 14 bombs were dropped by our planes. Four fighting planes left the station on the afternoon of November 2 for the purpose of making a reconnaissance flight over Pola but this flight was not very successful due to poor visibility.

Although the station at Porto Corsini suffered no casualties directly due to enemy action, there were unfortunately four deaths from accidents. On August 11, James L. Goggins, landsman for quartermaster, United States Naval Reserve Force, fell in an M-5 while flying at the station and was instantly killed. On September 15, while testing radio apparatus Ensign Louis J. Bergen, United States Naval Reserve Force, and Gunner (R) Thomas L. Murphy, United States Navy, fell in an M-8 airplane and died in the hospital at Ravenna shortly afterwards from their injuries. George B. Killeen, coppersmith,

United States Naval Reserve Force, died on September 18 as a result of burns received in a gasoline torch explosion.

When it is considered that the station was always seriously handicapped by lack of planes and the spare parts and tools necessary to repair them, the results accomplished are altogether commendable and praiseworthy. The planes which had been promised by the Italian authorities were delivered only in small and insufficient quantities, owing to unexpected delays in production and the more urgent need of their own stations elsewhere. Twenty-one was the greatest number of machines ever at Porto Corsini at the same time and with the machines available a total of 745 flights were made during active war operations.

The air station at Pescara, the third station which the United States had consented to take over and operate, was still under construction at the time of the agreement with the Italian Government and, although completed just prior to the armistice, it was never actually placed in commission due to the unexpected suspension of hostilities with Austria on November 4. The construction work at the Pescara station progressed extremely slowly due to the scarcity of labor, the difficulty of obtaining material, and the ravages of an epidemic of Spanish influenza among the workmen. The chief cause of delay in commissioning this station, however, was not the slow progress of the work of construction but the lack of airplanes, as the Italian authorities stated that they would be unable to supply any before December, 1918. It would have been manifestly unwise to divert any of the few available seaplanes to Pescara before the station at Porto Corsini was properly equipped. On October 22, a small advance party under the command of Ensign Joseph H. Green, United States Naval Reserve Force, was sent to Pescara to prepare the station for the arrival of American naval aviation personnel to man the station but upon the signing of the Austrian armistice the project of establishing an air station at Pescara was abandoned.

All naval air activities in Italy were under the command of the commander, United States naval aviation forces in Italy whose headquarters were located at the American Embassy, 2 Via Susanna, Rome. The first commander was Lieut. Commander John L. Callan, United States Naval Reserve Force, who assumed command on April 25, 1918. He was relieved on October 16, 1918 by Capt. Charles R. Train, United States Navy, who remained in command of all naval aviation forces in Italy, until they were returned to the United States. The commander, United States naval aviation forces in Italy, in turn, was under the command of the commander, United States naval aviation forces, foreign service, with headquarters in Paris.

CHAPTER VIII

THE NORTHERN BOMBING GROUP

The northern bombing group was organized for the purpose of bombing the German submarine bases in northern Belgium. It was composed of eight squadrons divided equally into day and night bombing units, day bombing being assigned to the Marine Corps and night bombing to the Navy. The group was commanded by Capt. D. C. Hanrahan, United States Navy, with headquarters at Antingues, France, and was operated under British control as a part of the aviation contingent attached to the Dover patrol. The aerodromes were located in northern France at St. Inglevert, Campagne Oye, Le Frene, Sangatte, and Alembom, and the assembly, repair, and supply base was established at Eastleigh, England. From this base the assembled planes were flown across the Channel to the aerodromes while the supplies were shipped across in barges and by ferry to the port of Calais.

On June 20, 1918, the first personnel for the northern bombing group were sent from the United States naval air station at Pauillac to the aerodrome site at St. Inglevert, France. This force formed the nucleus of night squadron No. 1. From this date to the armistice, personnel, supplies, equipment and material followed as fast as obtainable and the organization grew rapidly.

Pilots and observers were placed in aviation schools for intensive training in England, France, and Italy through the courtesy of these Governments. As soon as they completed the required school courses, they were given additional training in active British squadrons of the Fifth Group, Royal Air Force, where they were given actual war flights over the enemy's lines. Ground personnel were similarly placed in these British squadrons for training purposes. The officers of the headquarters staff were temporarily attached to the group headquarters of the Fifth Group, Royal Air Force where they received excellent training in operations, intelligence, aerial gunnery, bombs, aerial photography, etc. Advantage was taken of every opportunity to train the entire personnel operating and through the courtesy and assistance of Brig. Gen. Charles Lamb, Royal Air Force commanding the Fifth Group, Royal Air Force, this was carried out with such rapidity that the personnel of the northern bombing group was in all respects ready for independent war operations in advance of the receipt of the first planes.

The types of planes which were adopted for the use of this group were the Caproni and Handley Page bombers for night bombing and the DH-4 and DH-9A for day bombing. On August 11, 1918, the northern bombing group received its first plane. This was a Caproni bomber equipped with three F. I. A. T. engines and was flown from the acceptance field at Furino, Italy, to the aerodrome at St. Inglevert by the group's own personnel. Four days later, on August 15, 1918, this plane made a successful night raid on the submarine shelters at Ostend, Belgium. As additional planes were received they were immediately placed in active service against the enemy.

Due to the scarcity of planes, the operations of the northern bombing group as such were greatly restricted and pilots, observers, and gunners of the group often assisted the British in raids conducted by British squadrons.

The enemy objectives of the northern bombing group were the submarine bases in Belgium up to September, 1918. The enemy submarine activities from Belgian ports ceased at this time and all raids thereafter were generally on the railway junctions, railway yards, canals and canal docks, at Thuront, Thielt, Steenbrugge, Eecloo, Ghent, Deyuze, and Loheren and on ammunition dumps, supply dumps, and aerodromes in connection with the Belgian offensives. These raids were carried out with the view of hindering, as much as possible, the retreat of the enemy. During this period the enemy aircraft were especially active on the Belgian front and our planes were generally attacked by these enemy planes while on raid.

The enemy forces had retreated so far by the end of October, 1918, that it was found necessary to move the squadrons of the northern bombing group to aerodromes farther east, closer to the enemy's lines. So on October 27 preparations were started to move the group to selected aerodromes in Belgium. At the time of the armistice one squadron of the day wing was completely housed on the aerodrome at Knessalans, Belgium, while the other day squadrons were in the process of moving. Two night squadrons were housed on the aerodrome at Mari Alta, Belgium. The remaining personnel of the group had finished preparations for the move. The seaplane station at Dunkirk, France, which was attached to the northern bombing group, was moved to Zeebrugge Mole. These aerodromes in Belgium and Zeebrugge Mole were formerly occupied by squadrons of the enemy and a great quantity of enemy material was used in housing our squadrons. This movement had to be accomplished by motor transport over terrible roads for the greater part of the distance as there were no railroads available.

After the armistice the squadrons were all moved back to their original aerodromes and from there evacuated to the United States. The complete demobilization of the group was finished on February 10, 1919. The total force in the field on the date of the armistice was about 250 officers and 2,400 enlisted men and at the group assembly and repair base at Eastleigh about 220 officers and 2,200 enlisted men, totaling around 470 officers and 4,600 enlisted men for the entire group.

The northern bombing group dropped a total of 155,998 pounds of bombs on various naval and military objectives in Belgium during its existence.

CHAPTER IX

MARINE CORPS AVIATION

Marine Corps aviation began on May 21, 1912, when Lieut. Alfred A. Cunningham was ordered to join the four Navy pilots who at that time comprised all there was of naval aviation. Shortly thereafter, several enlisted marines were also ordered to aviation duty, forming the nucleus of the present Marine Corps section of naval aviation. This Marine Corps section was gradually increased and took part in the naval aviation operations at Vera Cruz, Mexico, and in Haiti and San Domingo.

At the time of the entrance of the United States in the World War the Marine Corps section of naval aviation consisted of five officers and 30 enlisted men stationed as part of the complement of the naval air station, Pensacola, Fla. It was realized that a large part of the duties of Marine Corps aviation would require flying landplanes and hence a combination land and water station was established for Marine Corps flyers at the navy yard, Philadelphia. An aviation unit officially designated the Marine Aeronautic Company was organized at this new station in the latter part of April, 1917, and training in land flying was immediately begun. On October 12, 1917, this Marine Aeronautic Company, then consisting of 34 officers and 330 enlisted men, was divided into the First Aviation Squadron consisting of 24 officers and 237 enlisted men and the First Marine Aeronautic Company consisting of 10 officers and 73 enlisted men. On October 14, 1917, the First Marine Aeronautic Company was transferred to Cape May, N. J., and took over the naval air station at that place. On December 7, 1917, the First Marine Aeronautic Company composed of 12 officers and 133 enlisted men was ordered to naval base 13, Ponta Delgada, Azores. The organization arrived in the Azores on January 21, 1918, and operated an antisubmarine patrol station of 10 R-6 seaplanes, 2 N-9 seaplanes and 6 HS-2L flying boats. The station was ordered to be abandoned on January 24, 1919, and shortly afterwards the organization returned to the United States, arriving at the Marine flying field, Miami, Fla., on March 15, 1919. This company was the first completely equipped American aviation unit to leave the United States for service in the war.

On October 17, 1917, the First Aviation Squadron was transferred from the Marine flying field, Philadelphia Navy Yard to the Army training field at Mineola, Long Island, where further instruction and training was carried on in land flying. On December 31, 1917, this organization was transferred to Gerstner Field, Lake Charles, La. In March, 1918, the Marine flying field, Miami, Fla., was established and on March 31, 1918, the First Aviation Squadron was transferred to that field from Lake Charles, La.

Upon the return, in January, 1918, of Maj. Alfred A. Cunningham from observation duty in France, he recommended to the Navy Department the establishing of a Marine Corps land aviation force of not less than four squadrons to operate in the Dunkirk area against the submarine bases at Ostend, Zeebrugge, and Bruges. This project was approved by the Secretary of the Navy and immediate steps were taken to organize this force and secure the necessary equipment. Four squadrons and a headquarters company were organized and trained at the marine flying field, Miami, Fla., and the planes and equipment were secured from the Army. Before this organization was ordered

abroad a cablegram was received from United States naval aviation headquarters in France recommending that the number of squadrons for this project be doubled and that these additional squadrons be composed of Navy personnel. This recommendation was approved and the revised project called the northern bombing group. The four Marine Corps squadrons were known as the day wing, northern bombing group.

On July 13, 1918, the First Marine Aviation Force, consisting of squadrons A, B, C, and headquarters company, left Miami, Fla., and embarked on board the U. S. S. *Dekalb* at New York City for France, July 18, 1918. This organization consisted of 109 officers and 657 enlisted men. On July 31, 1918, the day wing disembarked at Brest, France, and proceeded to its aerodromes between Calais and Dunkirk. The personnel of the day wing were completely organized and ready for service within two weeks after their arrival on French soil. In September, 1918, Squadron D of the day wing, consisting of 41 officers and 189 enlisted men, arrived in France, completing the four squadrons of the day wing.

Marine Corps aviators of the day wing performed service both with British aviation squadrons at the front, due to the scarcity of American planes, and also independently. The total number of raids made by Marine Corps personnel was 57, during which 52,000 pounds of bombs were dropped. These raids did considerable damage and brought back valuable information. It was learned after the armistice that one of these raids resulted in the death of 60 enemy officers and 300 enlisted men. Four Marine Corps aviators were killed or died of wounds, while 12 enemy aircraft were shot down as a result of these raids. The type of planes used by the day wing were De Haviland 4's and 9's. Early in December, 1918, the day wing received orders to return to the United States and embarked on December 6 on board the U. S. S. *Mercury* at St. Nazaire, France, arriving at Newport News, Va., December 21, 1918.

The following tables give the strength of Marine Corps aviation at the outbreak of war and at the time of the armistice:

On April 6, 1917		*On November 11, 1918*	
Commissioned officers	4	Commissioned officers	250
Warrant officers	1	Warrant officers	32
Enlisted men	30	Enlisted men	2,180

CHAPTER X

THE TRANS-ATLANTIC FLIGHT

The NC flying boats which were used on the trans-Atlantic flight marked the culmination of the war development of aircraft in the Navy. In August, 1917, Admiral Taylor, chief constructor, initiated the project of building the largest flying boats in the world, to be of novel construction, and to attempt to cross the Atlantic. This project was conceived with a view to getting antisubmarine planes into the war zone independent of shipping. The plan was to produce these great flying boats in quantity and to fly them across the Atlantic to the center of submarine activity. The armistice came before this plan could be carried out, but the trans-Atlantic flight which was undertaken in May, 1919, was strictly in line with the original purpose of the design and really in the nature of a service trial. These flying boats were designated NC, the N for Navy and the C for Curtiss, because they were the joint production of the Navy and the Curtiss Engineering Corporation. The designers of the NC were Mr. G. H. Curtiss and Mr. W. L. Gilmore, of the Curtiss Co., and Commanders Westervelt, Richardson, and Hunsaker, of the Navy.

The hull of the NC was 45 feet long by 10 feet beam. The bottom was a double-plank V with a single step somewhat similar in form to the standard Navy pontoon for smallest seaplanes. Five bulkheads divided the hull into six water-tight compartments with water-tight doors and a wing passage for access. The bare hull, as completed by the builder and ready for the installation of equipment, weighed only 2,800 pounds, yet the displacement was 28,000 pounds, this giving a ratio of 0.1 pound of boat per pound of displacement. This lightness of construction was attained by a careful selection and distribution of materials. The keel was of Sitka spruce, while the bottom planking was of Spanish cedar. Longitudinal strength was given by two girders of ash braced with steel wire. To guarantee water-tightness and yet keep the planking thin there was a layer of muslin set in marine glue between the two plies of planking.

The wings carried a load of 11.7 pounds per square foot in the air, but the structural weight was only 1.2 pounds per square foot. The total wing area was 2,380 square feet. The main wing spars were hollow spruce boxes. Each rib was a truss designed like a bridge consisting of continuous cap strips of spruce, corresponding to the upper and lower cords of a bridge truss, tied together by an internal web system of vertical or diagonal pieces of spruce. The ribs were 12 feet long but only weighed 26 ounces each. An interesting detail of the wing construction was the hinged leading edge which enclosed the control cables to the ailerons. This eliminated the air resistance of these cables, while at the same time they were accessible for inspection by merely swinging up the leading edge on its hinges.

The tail surfaces of the NC were made up as a biplane which resembled in general appearance and size the usual airplane. The NC tail was in fact twice as large as the ordinary complete single-seater fighting airplane. The tail was over 500 square feet in area, and the structure was supported by three hollow spruce booms braced by steel cable in such a way as to remain clear of all breaking seas and to permit a machine gun to be fired straight aft from the stern compartment without interference. This method of

support was a radical change from former American and foreign practice, but resulted in several advantages besides an important saving in weight.

The four Liberty engines which drove the boat were mounted between the wings. At 400 horsepower per engine, the maximum power was 1,600 horsepower, or, with the full load of 28,000 pounds, 17.5 pounds carried per horsepower. One engine was mounted with a tractor propeller on each side of the center line, and on the center line the two remaining engines were mounted in tandem, or one behind the other. The front engine had a tractor propeller and the rear engine a pusher propeller. This arrangement was novel and had the advantage of concentrating weights near the center of the boat so that it could be maneuvered more easily in the air.

The NC flying boat weighed when fully loaded 28,000 pounds, and when empty, but including radiator water and fixed instruments and equipment, 15,874 pounds. The useful load available for crew, supplies, and fuel was, therefore, 12,126 pounds, or over 43 per cent. The NC was capable of an endurance flight of 1,400 miles, carrying a crew of five men (900 pounds); radio and radiotelephone, 220 pounds; food and water, signal lights, spare parts, and miscellaneous equipment, 524 pounds; oil, 750 pounds; and gasoline, 9,650 pounds. The radio outfit was of sufficient power to communicate with ships 200 miles away. The radiotelephone could be used to talk to other planes in a formation or within a distance of 25 miles.

The first of the four NC flying boats which were constructed was completed and flown on October 4, 1918, or approximately one year from the commencement of the design. In this test, although the craft was somewhat tail heavy, its operation as a whole was very satisfactory, and indicated that the work of the designers had been a success. It was found necessary to make slight changes in the position of the horizontal stabilizer to neutralize this tail-heavy condition, but otherwise no radical changes were required in the design or construction. The second NC boat, the *NC-2,* was completed in March, 1919, and the *NC-3* and *NC-4* were completed in April, 1919. Due to injury to two outer wing sections while at anchor in a gale late in March, 1919, the *NC-1* was put temporarily out of commission. After the completion of weight-lifting trials on the *NC-2,* the outer wing sections of that boat were transferred to the *NC-1,* as no spares were available. As a result of this regrettable injury, only three NC boats remained available for the trans-Atlantic flight.

The three flying boats, *NC-1, NC-3,* and *NC-4,* were placed in regular commission on May 2, 1919, and Commander J. H. Towers, United States Navy, assumed command of NC Seaplane Division 1, comprising these three boats. This was the first time in the history of the Navy that any aircraft had been placed in regular commission. In addition, Commander Towers was detailed to command the *NC-3,* which therefore became the flagship of the division; Lieut. Commander P. N. L. Bellinger was detailed to command the *NC-1* and Lieut. Commander A. C. Read to command the *NC-4.*

The plans for conducting the trans-Atlantic fight were complete in every detail. In the first place the route from Newfoundland to Portugal via the Azores was chosen because its distances were the shortest and its areas of uncertain weather conditions the least. A patrol of destroyers was established along this route, so as to reduce the danger to

personnel to a minimum. At all ports of call, mother ships were stationed in order to provide fuel, spare parts, repair facilities, etc., for the planes.

The actual start of the three airplanes, *NC-1*, *NC-4*, and *NC-4*, on their attempt to fly across the Atlantic, was made from the United States naval air station, Rockaway, Long Island, on May 8, 1919. The first leg of the flight was from this station to Halifax, Nova Scotia. Leaving Rockaway at 10 o'clock in the morning, all three airplanes preserved formation. Everything went well until about half-past 2 in the afternoon, when the *NC-4* was forced to drop astern because of engine trouble. Shortly afterwards additional engine trouble forced the *NC-4* to land about 80 miles east of Cape Cod and the plane was taxied under its own power to the naval air station at Chatham, Mass. In the meantime the *NC-1* and *NC-3* continued their flight to Halifax and arrived there around 7 o'clock in the evening.

As preparations for starting on the second leg of the flight from Halifax to Trespassy, Newfound, had just been completed on the morning of May 10 and the *NC-1* was taxying about the harbor waiting for the *NC-3* to take off first, a starting motor on the latter broke. The *NC-1* was thereupon directed to proceed to Trespassy by itself and the *NC-3* started shortly afterwards. Both planes arrived at Trespassy in the late afternoon of May 10. These two planes were joined at Trespassy by the *NC-4* on May 15, the *NC-4* arriving there from Chatham via Halifax.

Personnel of the *NC-1* and *NC-3* immediately assisted the *NC-4* in changing one engine, fitting the airplane with new propellers and getting her in all respects ready for departure the following afternoon. Reports from the Weather Bureau and from the meteorological officer and the Weather Bureau representative at Trespassy all indicated very favorable weather and advised a start on the afternoon of May 16. A start was decided upon, and all three airplanes took off that afternoon for Horta, a port in the Azore Islands.

Formation was assumed and was fairly well preserved during the afternoon and early evening. Later when it became dark and overcast, however, and the running lights of the *NC-3* stopped functioning due to grounding of the circuit by salt spray, the three planes were soon lost to each other and each continued the flight independently. A little before dawn the *NC-4* began flying much faster than either the *NC-1* or *NC-3*, because its pilots did not feel entirely stable at the higher angle of incidence given by lower speed. About 8 o'clock in the morning the three planes encountered intermittent rainfalls, and a very thick fog. As the Azores were approached the fog became thicker and thicker and interfered seriously in determining the course which was being flown, as it was impossible to obtain a reliable sextant altitude of the sun. Various altitudes were tried to avoid the fog, but it merged with the clouds which, most of the time, extended very high and made flying at any altitude over 1,000 feet very difficult for the pilots.

Shortly before noon the *NC-1* landed for the purpose of determining its position by taking radio-compass bearings on destroyers but the water conditions were worse than had been expected and entirely too rough to take off into the air again. About a 22-mile wind was blowing, with a cross sea and a heavy swell. For four hours attempts were made to call to destroyers for aid by means of the radio but with no success. In the

meantime the sea had carried away the elevators, and a portion of the wings. Finally late in the afternoon the crew of the *NC-1* were picked up by a passing steamer, the Greek ship *Ionia*, and taken to Horta while the plane itself was subsequently sunk to remove a menace to shipping.

At 1.30 p. m. on May 17, the *NC-3* also landed in order to obtain radio-compass bearings and was unable to take off again due to the rough sea and to damages received in landing. The plane's position was obtained, however, by means of radio-compass bearings as being 34 ½ miles southwest of Horta. Due to injury to the radio apparatus evidently received while landing, the *NC-3* now found itself able to receive messages but unable to send any, except on a short-range battery set. Those messages, however, were not intercepted by the ships. A heavy storm arose that afternoon and for two and a half days the *NC-3* fought that storm and endeavored to utilize the very limited sailing qualities of the *NC-3* toward getting to the Island of San Miguel. This was finally accomplished and on the evening of May 19 the *NC-3* reached the port of Ponta Delgada.

The *NC-4* reached Horta safely on the afternoon of May 17, completing the distance of 1,200 nautical miles from Trespassy to Horta in 15 hours and 18 minutes. The *NC-4* was thus the only plane left to continue the flight. The personnel of the other two planes were taken aboard the *Bainbridge* to Lisbon and then to Plymouth via the *Rochester*.

The *NC-4* was held at Horta by fog and later by a gale until May 20. On the afternoon of this day the flight from Horta to Ponta Delgada was accomplished, the trip consuming about two hours. Here the *NC-4* waited six days for favorable weather and sea conditions as the plane was too near its goal to take any unnecessary chances for the sake of completing the flight a day or two sooner. Finally early in the morning of May 27, the *NC-4* departed from Ponta Delgada for Lisbon and arrived at Lisbon late in the afternoon of the same day.

On the 30th of May the *NC-4* got an early morning start for the last leg of the trip from Lisbon to Plymouth. After about two hours of flying, however, a leak of unknown origin was discovered in the port engine and it became necessary to land in the mouth of the Mondego River, near Figueira, Portugal, to make repairs. These repairs were soon completed and the *NC-4* left about 2 o'clock in the afternoon for Ferrol, Spain, as it was too late by this time to attempt to make Plymouth before dark. Ferrol was reached about 4.30 in the afternoon. The following morning the *NC-4* left Ferrol for Plymouth and at 1.30 that afternoon (May 31) arrived safely at Plymouth, England, thus being the first aircraft to cross the Atlantic Ocean by air.

CHAPTER XI

DEVELOPMENT OF HEAVIER-THAN-AIR CRAFT

The first airplanes purchased by the Navy were two of Curtiss type and one of Wright type. One Curtiss was a 80-horsepower seaplane convertible to land plane and the other was a 40-horsepower land plane which was later converted into a 80-horsepower seaplane. Both of them were of the pusher type with bamboo frame and tail and equipped with front as well as tail elevators. These front elevators were found unnecessary and were removed. They were single pontoon with wing tip floats. The Wright was a 32-horsepower airplane of the usual Wright type, equipped with two propellers. This airplane was later converted into a twin-float seaplane. The speed of the Curtiss seaplanes was about 60 miles per hour and the Wright about 42 miles per hour. The Curtiss carried 16 gallons of gasoline and the Wright about 10 gallons. All these seaplanes gave a fairly good performance, considering the state of development at that time. They were all very lightly constructed, however, and the fact that there were no serious structural failures is remarkable.

In the summer of 1912 a Burgess Wright seaplane was delivered, also an improved Curtiss seaplane. In the late autumn of 1912 the first Curtiss flying boat was delivered. This was used for catapult tests and then was sent to Guantanamo.

During 1913 four more planes were delivered. These were 2 Curtiss flying boats, 1 Curtiss amphibian boat (OWL), and 1 Wright 60-horsepower seaplane. Early in 1914 three more Curtiss boats of an improved type were delivered, also the Burgess-Dunne seaplane. This last-named seaplane had its wings arranged in V form and had no tail surfaces. It was inherently very stable and therefore difficult to fly. It was equipped with a Curtiss 80-horsepower engine. There was also delivered a Burgess flying boat, which was rather similar to the Curtiss type except that the hull was long and narrow and seats were in tandem instead of side by side. In the autumn of 1914 two more Curtiss single-float seaplanes were delivered. These were of greater wing surface than the earlier types and had much larger floats.

During 1915 another Burgess-Dunne and five Curtiss seaplanes were purchased by the Navy. All six of these seaplanes were equipped with the OXX 85-horsepower motor and were capable of a speed of about 63 miles per hour.

During 1916, the purchase of aircraft by the Navy was considerably increased, 60 machines being obtained and in practically all, an improvement in engine power was procured. Different manufacturers produced a variety of machines, the most important development being the tractor type of airplane in which the engine was placed forward of the pilot, permitting it and not the pilot, in case of a crash, to take the force of the impact. Fatalities as the result of crashes were immediately reduced with the advent of the tractor type. Among the planes obtained during this year were Thomas, Burgess, Martin, and Sturdevant seaplanes. In the autumn of 1916, the Navy's first production order was placed with the Curtiss Co. for 30 type N-9 training machines. The successful results of experimental development during earlier years was clearly shown in the aircraft

purchased in 1916, as during that year naval planes began definitely to assume their present-day form.

In the early months of 1917 prior to the entry of the United States in the World War, 11 planes were purchased by the Navy, among which were the Curtiss R-3 seaplane with twin floats and the H-12 flying boat equipped with two V-2 Curtiss motors developing about 200 horsepower.

Upon the declaration of war against Germany on April 6, 1917, it became important at once to develop aircraft useful for other purposes than mere flying. The suppression of the submarine was an urgency, and for offensive operations against submarines, machines of long endurance and of large carrying capacity were immediately necessary. However, the first requirement was for more training machines, and the Curtiss Co. was given an order for 64 more N-9's and 76 of a larger type designated as R-6. These orders filled the available capacity of the Curtiss Co., which at that time had large orders for training airplanes from the Army and the British Government. To permit expansion of the training program, additional orders were placed with each of the six other aircraft manufacturers for sample training planes of their own designs. Several satisfactory types were submitted for tests and orders were placed in the summer of 1917 as follows: Burgess Co. of Marblehead, Mass., 12 planes of Burgess design, plus 30 Curtiss N-9's; Boeing Co. of Seattle, 50 planes of Boeing design; Aeromarine Co. of Keyport, N. J., 200 planes of Willard design; Curtiss Co. of Buffalo, 15 Curtiss Model F's and 122 Curtiss R-6's. These orders were delivered at a reasonably satisfactory rate and the training of aviators was at no time held back seriously for lack of satisfactory training planes.

With the training program well under way, it remained to determine what part naval aircraft would play in the war and then to provide the necessary material. At first it was not known whether the Navy would send aircraft abroad at all, but it was decided by September, 1917, that the Navy should operate 15 seaplane stations on the coasts of France and Ireland from which seaplanes would patrol the submarine infested coastal waters through which American troops and supply ships were to pass.

Attempts were made to obtain information from abroad of any successful types in order that their manufacture might be undertaken, and in July, 1917, a board of officers was sent to England, France, and Italy to obtain this information at first hand. This board on its return, September 1, 1917, reported that there was no wholly satisfactory foreign seaplane suitable for coastal patrol; and that American types equipped with the new Liberty engine would be superior to any abroad. The joint Army and Navy technical board, acting upon this information, and with the knowledge that 15 coastal air stations abroad would be operated by the United States Navy, prepared a building program which was approved by the Secretary of the Navy in October, 1917.

This initial program provided for 1,185 single Liberty engine flying boats known as the HS-1 and 235 twin Liberty engine flying boats known as the H-16. Provision of but two types with a single type of engine simplified production and maintenance. Two types of flying boats were necessary as the large boats could not be constructed in sufficient quantities, involved shipping difficulties, and drew too much water for use on certain of the French stations.

The Curtiss HS-1 flying boat was developed from a Curtiss design known as H-14, which was brought out in the summer of 1917. It was a typical Curtiss type of flying boat having a length of 38 feet and a wing span of 62 feet. The gross weight in the air of 5,900 pounds, included a crew of 2 men, one machine gun and two 180-pound bombs. The maximum speed of 87 miles could be maintained for 4 hours. After production had got well underway, information was obtained that the 180-pound bomb was not really effective against submarines and that heavier bombs as well as a radio set would be needed. In order to permit the carrying of this extra load, it was necessary to increase the wing area. This was done by designing a 6-foot wing panel to be inserted out board of the engine section on each side. The result of this change was an increase in the span to 74 feet and an increase in the total weight to 6,500 pounds. A larger rudder was also provided for the planes thus modified and these modified planes were designated model HS-2.

The production of HS-2 flying boats is summarized in the following table:

	Number Ordered	Shipped abroad	Delivered	Canceled after Armistice
Curtiss A. & M. Corporation, Buffalo, N. Y	674	213	674	0
L.W.F. Engineering Co., College Point, N. Y	300	10	250	50
Standard Aircraft Co., Elizabeth, N. J.	150	6	80	70
Gallaudet Aircraft Co., East Greenwich, R. I.	60	0	60	0
Boeing Airplane Co., Seattle, Wash.	50	0	25	25
Longhead Co., Los Angeles, Calif.	2	0	2	0
Total	1,236	229	1,091	145

The other type adopted for production by the joint Army and Navy technical board was the Curtiss *H-16* flying boat equipped with twin Liberty engines of 360 horsepower each. This type had been developed during 1915 and 1916 by the Curtiss Co. and the British Admiralty. The original model had been the Curtiss *America* of 1914 which was built just prior to the beginning of the World War for a proposed trans-Atlantic flight. The *America* was not successful because no high-power engines were available, but the British Admiralty ordered a number of them and fitted them in England with two French Anzani engines of about 100 horsepower each, known as "small America's," and they were used to patrol submarine areas. Curtiss then designed the H-12, a larger machine on the same lines which was fitted in England by the Admiralty with twin Rolls-Royce engines. The Admiralty redesigned the hull of the *H-12* to provide greater strength and introduced for the first time the steep Vee bottom with double steps. In the early part of 1917 the Curtiss Co. was given a large order for the British redesigned boat, known in England as *F-3* or "large America" and in the United States as *H-16*. This machine was already in production at the Buffalo works of the Curtiss Co. when the United States declared war but the design was arranged to mount Rolls-Royce engines. It

became necessary to redesign the *H-16* to provide for Liberty engines. This redesign of the *H-16* involved extensive changes in the plane, but time was too valuable to work out a trial installation. Production was started at once and by a combination of good luck and good management no serious difficulties developed.

The *H-16* was a biplane flying boat, 46 feet in length, having a span of 96 feet, and equipped with two 360-horsepower Liberty engines. The weight empty was 7,400 pounds and loaded 10,900 pounds. The useful load included four men, radio, two 230-pound depth bombs, and four machine guns. The maximum speed was 95 miles. At this speed the endurance was four hours but patrols at cruising speed of nine hours were made in the war zone.

During 1917 the British Admiralty redesigned the *H-16* again to produce a boat capable of carrying more depth bombs and possessing greater endurance. A sample machine was successfully developed in the spring of 1918 and the plans thereof were furnished the Navy Department. This machine was designated the model *F-5* flying boat. The *F-5* had an allowable full load of 1,300 pounds and could carry four depth bombs against two for the *H-16*, besides having a cruising endurance of 11 hours against 9 for the *H-1*6. The advantages of this flying boat over the *H-16* were obvious and hence, as the *H-16* contracts were completed, it was decided to replace them by orders for F-5 flying boats with the same manufacturers. Before this could be done, however, it was necessary to redesign the British *F-5* at the Naval Aircraft Factory in order to adapt it for quantity production on the assembly system, and in order to use Liberty engines instead of the British Rolls-Royce engines. This redesigned model was designated the *F-5-L*.

The production of *H-12's*, *H-16's* and *F-5-L's* is summarized in the following table:

	Number ordered	Delivered	Shipped abroad	Canceled after Armistice
Curtiss A. & M. Corporation, Buffalo, N. Y	19 H-12	19	0	0
	74 H-16	74	62	0
	410 F-5-L	60	0	350
Curtiss Engineering Corporation Garden City, Long Island	50 H-16	50	18	0
Naval Aircraft Factory, Philadelphia, Pa	150 H-16	150	78	0
	680 F-5-L	137	0	543
Canadian Aeroplane (Ltd.), Toronto, Canada	50 F-5-L	30	1	20
Total	1,433	520	159	913

Production of airplanes in appreciable quantities was first reached in April, 1918, at which time the single-engine flying boats were being received from the various manufacturers at the rate of six per week and the twin-engine boats at the rate of three per week. By the summer of 1918 aircraft production was well underway and had reached its height about September 1, when single-engine flying boats were being delivered at the

rate of 38 per week, twin-engine flying boats at the rate of 13 per week and school or training planes at the rate of 32 per week.

During 1918, several new types of seaplanes were constructed for the Navy Department, and trials were conducted to determine their suitability either as training or as service machines. The order for each of these seaplanes was placed with the definite purpose of development of some particular need in the future program, if the war had continued.

With reference to training machines of the flying-boat type, the Curtiss model F had proved itself the most satisfactory in use, but it was desired to develop a machine of better structural character along the same lines. Encouraged by the Navy Department, the Aeromarine Plane Motor Co. developed its Model 40-A and the Curtiss Engineering Corporation its MF (modified F) boat, both of which were recommended by the trial board for adoption and contracts awarded shortly before the armistice.

Several service machines of particular interest, some of which presented a distinct advance in airplane design, were also constructed and tried out in the summer and fall of 1918. Of these the most important were the *NC-1*, the Curtiss model 18-T (Kirkham Fighter), the Curtiss model HA (Dunkirk Fighter), and the Gallaudet *D-4*.

The *NC-1* was a large flying boat, built by the Curtiss Aeroplane Co. under the direction of the Navy Department which was responsible for the design. It was a biplane having a span of 126 feet for the upper wing, and a length of 68 ½ feet from the bow to the end of the tail surfaces. The normal weight, fully loaded, was 22,000 pounds. It was equipped with three Liberty engines, each located in a nacelle between the wings. The *NC-1* made a flight at Rockaway, N.Y., on November 27, 1918, with 51 men aboard, thereby establishing the world's record for number of passengers carried.

The Curtiss model 18-T, or Kirkham Fighter, was a land machine designed and constructed for the Navy Department by the Curtiss Engineering Corporation. Had the war continued it is likely that this type would have been put into production for use on the western front in the protection of bombing squadrons. It was a 2-seater combat plane having a span of 32 feet and a weight, fully loaded, of 2,800 pounds. The sample plane made on trials a high speed of 162 miles an hour which established a new world's record for speed. The model 18-T was equipped with the Curtiss K-12 engine.

The Curtiss HA, or Dunkirk Fighter, was a single-pontoon seaplane, equipped with one Liberty engine. It was a 2-seater combat plane brought out in 1918 as an answer to high performance German seaplanes which were interfering with the bombing operations being conducted by the Navy against German submarine bases on the Belgian coast. Its maximum speed of 125 miles per hour was then a remarkable performance for a seaplane. Due to the change in conditions brought about by the end of the war, the HA was never put into production.

The Gallaudet *D-4* was a 2-seater combat seaplane. Carrying its normal load of 434 pounds of ordnance, the plane had a high speed of 119 miles per hour and at this speed the endurance was two and one half hours. It was the only gear-driven plane developed during the war and was designed and built by the Gallaudet Aircraft Corporation of East Greenwich, R. I. The *D-4* was fitted with a single Liberty engine mounted in the fuselage, which drove by means of a ring gear, a propeller which is

situated immediately behind the wings. The fuselage or tail structure of the plane extended through the center of the ring gear carrying the propeller.

During the World War every effort was made to produce aircraft for countersubmarine work and for convoy and patrol duty to be operated from shore stations. This led to the development of large flying boats and at the end of the war this type existed in a fairly satisfactory state of perfection. Since then attention has been diverted from this type of aircraft to the development of aircraft suitable for use with the fleet. Fleet aviation requires small and handy combat planes of high performance, planes for scouting, observation and spotting gunfire, and torpedo and bombing planes for offensive use against an enemy fleet.

Shortly after the war the General Board had an exhaustive study of the various functions of naval aircraft and decided that the following types of airplanes were required by the Navy:

(a) Scouting airplanes for scouting work at sea with the fleet, and of such restricted size that they can be carried on aircraft carriers.

(b) Bombing airplanes for use with the fleet to bomb enemy vessels and bases; also to be carried aboard carriers.

(c) Torpedo airplanes to carry and launch torpedoes against enemy vessels. These planes are also to be carried on carriers.

(d) Observation airplanes to be carried aboard battleships, aircraft carriers, and other vessels; for short-range scouting and for observation of gunfire.

(e) Fighting airplanes to be carried on vessels and carriers; to be used to obtain local control of the air.

(f) Patrol airplanes to operate from naval district bases to be used for patrol and convoy work.

The development of these types has been pushed vigorously since the war and the practice has been adopted of standardizing one model of plane for each type of service for reasons of production, economy, and maintenance. Nevertheless, the Bureau of Aeronautics has kept an open mind and has continued to build experimentally, and try out in limited numbers, new designs of planes incorporating new inventions and ideas with a view to making improvements which can either be incorporated on the standard model, or which will lead to the development of a new design to replace the standard model.

Scouting at sea has developed into an important function of naval aircraft and requires planes possessing long endurance, adequate protective armament, and a powerful radio apparatus. The standard postwar scouting plane is the CS type. The CS is a 2-seater, convertible plane using twin floats as a seaplane and having a cruising radius of over 1,500 miles in about 24 hours. At full speed, its endurance is around 14 hours. The full speed is 103 miles per hour and the cruising speed 83. The CS models are equipped with a 525 horsepower Wright T-2 or T-3 engine, have a wing area of 826 square feet and weigh, fully loaded, about 10,000 pounds.

No airplane primarily designed for bombing operation has been developed as the CS, mentioned above, incorporates the features of a bomber. The CS type has been developed as a combination scouting, bombing, and torpedo machine since all three of

these purposes require heavy weight carrying and there is obviously gain in economy by combining the three functions in one type of plane. As a torpedo plane, the CS carries the standard torpedo, as a bombing plane it carries the equivalent weight of bombs, and as a scout, it carries additional fuel tanks in lieu of either torpedo or bombs. The CS, fitted as a bomber, carries a bomb load of about 1,500 pounds and has a cruising radius of around seven hours. In this condition, an additional seat is provided for the bomber near the tail of the machine with his bomb sight looking out through a hole in the bottom of the fuselage.

In order to provide training and to develop the tactics of torpedo attack a number of torpedo planes, designated PT, were built in 1921 which were unsatisfactory as to power and speed and general aerodynamic qualities, but were the best that could be obtained promptly and with the funds available. The PT has been replaced by the DT type, developed by the Douglas Co. of Santa Monica, Calif., which has a better performance that the PT and is, in general, a compact fleet plane of modern type. The DT torpedo plane is equipped with either a Liberty or a Wright T-2 engine. It is supplied with twin pontoon landing gear, or land wheel type gear, so that it may be used either from the deck of a carrier or a field on shore, or as a seaplane in the ordinary manner. The DT has a wing area of 707 square feet and has a total weight of about 7,300 pounds. Its maximum speed is 106 miles per hour.

Observation planes for spotting gunfire are of relatively low speed but long endurance. The maximum speed of 120 miles has been realized with a cruising range of five or six hours at reduced speed. It appears more important to have endurance in the air than high speed for this type. A service ceiling or altitude of 10,000 feet is considered necessary. The span and general size of the observation plane is limited by handling facilities aboard ship, and the total weight is limited by the capacity of the catapults. To a certain extent this type can also perform the duties of scouting in addition to spotting. The first standard observation plane to be developed was the UO type. The UO is a single float convertible airplane equipped with a 200 horsepower Wright J engine. It has a wing area of 290 square feet, a service ceiling of about 17,000 feet, and a maximum speed of 121 miles per hour. In 1924 two experimental types of observation planes, the MO and the NO, were constructed. The MO is a metal monoplane in which the observer sits in a cabin beneath the wing and has a clear view on either side. The NO is a biplane of more compact construction and of better performance than the MO, but in which the observer has his view of the surface obstructed at times by the presence of the lower wings. Both planes carry a crew of three men, a pilot, an observer who is also the radio operator, and a gunner for protection. The relative merits of these two types is to be determined by service tests.

The fighting planes developed since the war have been of a small, fast, quickly maneuverable type, carrying one person with at least two fixed machine guns. On account of their relatively high power, fighting planes are able to shoot down larger and more cumbersome types of plane, and, as such, are believed to constitute the best defense of a fleet against enemy attack from the air. The general idea is to have with the fleet as many fighting planes as possible in order to send into the air at a given time the maximum number, either for attack, or for defense, and hence it is necessary to carry

fighting planes on every available vessel. The only standard fighter which has been developed to date is the TS type. The TS was designed by the design section of the Bureau of Aeronautics under the direction of Commander Hunsaker and the plane built by the naval aircraft factory and by the Curtiss Aeroplane Co. It is designed to give the smallest and most compact plane with the maximum facilities for take-down and erection aboard ship. All wires and turnbuckles in the wing bracing are eliminated to facilitate rapid erection. This type is equipped with an air-cooled, radial engine, the Wright J-1, rated at 200 horsepower. The full speed of the TS is about 120 miles an hour as a seaplane and about 127 miles an hour as a landplane. It has tankage for two and a half hours and can keep in the air at reduced speed more than three and a half hours. Its weight, fully loaded, is about 2,000 pounds.

The patrol type of airplane was well developed during the World War and the *F-5-L* is still the standard patrol plane of the Navy. A new type, the PN, has recently been developed, however, and it is intended to replace the *F-5-L* by PN's of greater speed and cruising radius. The PN is a modification of the *F-5-L*, using two 525 horsepower Wright T engines in place of the old Liberty 400 horsepower engines and with radical improvements in the design of wings and general structure. The *PN-7* has a wing area of 1,220 square feet, a maximum speed of 113 miles per hour, and a service ceiling of 10,500 feet. One of these machines made a 105-day cruise to the West Indies and return in 1924 without changing engines, the only replacement being one rocker-arm bearing. The time in the air was 150 hours. Though designed for a 14,000-pound load the *PN-7* has actually taken off readily with a load of 17,000 pounds. With a view to improving the PN type still further, a PN, with a hull and tail surfaces of metal, has just been constructed at the naval aircraft factory and designated the *PN-8.* This metal hull is 500 pounds lighter than the wooden hull and the use of metal tail surfaces has resulted in a saving of an additional 70 pounds. Water soakage has also been eliminated by constructing the hull of metal.

In addition to the tactical types of airplanes mentioned above, a training plane type has also been under development by the Navy since the end of the war. The main requirements of a training plane are exceptionally good flying qualities, low landing speed, dual control, and cheapness. The old war training type, the Curtiss *N-9*, remained the standard Navy training plane until recently when, after careful trials of several experimental designs, the Boeing NB was adopted to replace it. The NB is a tractor biplane, convertible for use on land or sea, and is equipped for gunnery training. It is fitted with a Wright air-cooled engine of 200 horsepower. This airplane has an electric-welded tubular steel fuselage. The weight of the NB, fully loaded, is about 2,900 pounds. It has a wing area of 344 square feet, a service ceiling of 11,150 feet and a speed range of from 47 to 97 miles per hour.

CHAPTER XII

DEVELOPMENT OF LIGHTER-THAN-AIR CRAFT

Lighter-than-air-craft activities of the Navy began on April 20, 1915, when the Navy Department contracted for one nonrigid airship with the Connecticut Aircraft Co. of New Haven, Conn., a concern which had secured the services of a German engineer, a German mechanic, and an Austrian pilot, supposed to be experts. This first dirigible designed and built under the supervision of this imported talent was a great disappointment, for when it was completed two years later, April, 1917, it was so much overweight that it could barely lift itself off the ground. Its envelope leaked and the power plant functioned badly. It did, however, actually fly, and since the firm had built the ship in good faith and at a cost greatly in excess of the contract price, it was formally accepted and designated the *D-1.* After a few short flights it was put back in its shed, deflated, and eventually broken up.

In December, 1916, a coast patrol airship of 12 hours' endurance was designed type B. This design was approved by the Secretary of the Navy on January 27, 1917. It was only intended to build one airship to this design as an experiment, but, as relations with Germany were becoming acute, the Secretary ordered the construction of 16 airships of the B type instead of one. This order was a thunderbolt, as delivery in any reasonable time was out of the question with existing facilities. No firms had knowledge or experience, and no time could be allowed them for experiment and research. There was also no time to build one airship to prove the design; all 16 were wanted at once. After many conferences with all possible manufacturers, arrangements were finally made for the production of these airships by a group of firms, pooling their knowledge and skill. Contracts were placed on March 14, 1917, for 9 airships to the Goodyear Co., 5 to the Goodrich Co., 2 to the Connecticut Aircraft Co., and 14 cars and engines (for the Goodyear and Goodrich ships) to the Curtiss Aeroplane Co. The Goodyear Co. also undertook to provide a flying field with shed and hydrogen plant, to conduct tests and trials, and to train naval airship personnel. The delivery of the B class airships took place between July, 1917, and June, 1918, during which time the Goodyear Co. trained the first naval airship detachment under the command of Commander L. H. Maxfield, United States Navy, at Akron, Ohio. These airships were successful in meeting their mission and at least the equal of the foreign product of that date. They had little direct war experience, being all used on this side of the Atlantic. However, these B class airships trained 170 pilots and on coast patrol did 13,600 hours or some 400,000 miles without a fatality. Designed for a 16-hour patrol, one ship at Key West was out 40 hours. One ship was in service for 15 months with its original envelope. Another kept one inflation of gas for 9 months, and was in the air during this time 743 hours.

In the spring of 1918 a larger and faster type of nonrigid airship to carry heavy depth charges was designed for antisubmarine activities overseas. This design provided high speed to cope with head winds, great endurance to follow convoys, and a duplicated power plant to lessen the chance of complete breakdown at sea and was designated type

C. The design proved to be highly successful and a full speed of 60 miles per hour was realized. Contracts were placed with Goodrich and Goodyear for 30 C class airships to be built in accordance with the bureau's design, the cars for all 30 to be made by the Curtiss Co. The first C class airship, the *C-1,* was completed in September, 1918, and on its maiden flight, October 22, flew a nonstop distance of 400 miles. As a result of the armistice, only 10 C class airships were completed and the contracts for the other 20 ships were canceled. A record flight for nonrigid airships was made by Lieut. Commander Coil on May 15, 1919, in the *C-5* when he flew from Montauk to Newfoundland, a distance of 1,022 sea miles, in 25 hours and 50 minutes.

The C class airship, although entirely successful, was criticized by the pilots because of certain features of design. An attempt to meet these criticisms was made in the D class. The envelope of this class was the C envelope with a 6-foot parallel strip added to the middle body. The cars of the D class were fitted with two Union engines mounted close together on outriggers at the stern. All the crew were thus forward of the engines, and no propeller blast went along the car. The fuel was all carried in tanks suspended on the envelope. These were radical changes from the C cars, where the engines were about amidships of the car, and all the fuel in tanks inside the car. The fins of the D class were also radically different from the C, being long and comparatively narrow as contrasted with the fairly short (fore and aft) and very wide fins of the C. Experience showed the changes of the car which were made in the D class to be productive of comfort for the flying crew, but trouble for the maintenance crew. The tanks on the bag were always difficult to fill and to keep tight. A great amount of tubing from tanks to engines had to be watched for leaks and secure attachment. An attempt was made to overcome these difficulties by modifying the design of the car and fitting an inclosed boat-shaped car carrying the fuel in the car. Five D class airships were built of the original design and one with the boat-shaped inclosed car.

By the middle of the year 1919 the Goodyear Co. had acquired quite a design staff and had built one or two airships for its own account and to its own designs. Among these was a single-engined pusher with an evelope only a little larger than the B ship. This seemed a worth-while variation on the B class and was acquired to determine the value of the type which was called the E class. A somewhat similar ship, having a car of slightly different design was also developed by Goodyear and purchased as the F class. The principal differences between these two ships were in the details of the car and in the fact that the engine of the *E-1* was fitted with reduction gearing to the propeller.

The bureau designed a large nonrigid called the G class, during 1919, but no ships of this type were ever constructed, as the project was abandoned in favor of rigids, for large sizes of airships. This G class ship was to have carried a 3-inch gun of the long recoil type together with a substantial bomb load and with this to have an endurance of 50 hours at 45 miles per hour or 25 hours at 60 miles per hour. It was found, however, that the carrying of the heavy armament and fuel required made it necessary to increase the envelope to a size considerably greater than was originally contemplated. The decision to abandon the G project was undoubtedly wise as experience with envelopes since then has conclusively shown that deterioration is rapid where the fabric is heavily stressed and that

it is very difficult to determine by service inspection just when this deterioration has proceeded to a dangerous degree.

A project which was the other extreme from the G design and sometimes referred to as an "animated kite balloon" was proposed in 1920. This project called for a very small airship, capable of being towed like a kite balloon, and yet able to maneuver on its own when the touring cable was slipped. A contract for a ship of this type, known as the H class, was placed with the Goodyear Co. in June, 1920. The trials of this ship were held in June and July, 1921. The ship was found to have most of the features desired, but required some improvement in the design of the engine bearers. The volume of the envelope was 43,000 cubic feet and a single Lawrance 60-horsepower air-cooled engine was used. A second ship of this type with the defects of the *H-1* corrected was built for the Army and this ship was entirely successful in its trials.

The letter I does not appear in the list of Navy nonrigid types on account of its similarity to the figure 1.

The last Navy nonrigid to be built to date is the *J-1*. The design of this type was prepared jointly by the Bureau of Aeronautics and the Goodyear Co. A serious endeavor was made to incorporate in it all the good points of all the preceding ships and to remedy all the defects which had been criticized. All the experience which could be relied upon was incorporated in this class. Trials of the *J-1* were held in the fall of 1922 and were very successful.

The general characteristics of this latest ship are as follows:

Volume of envelope	174,880 cubic feet.
Length of envelope	168 feet.
Maximum diameter of envelope	45 feet.
Length of car	30 feet.
Width of car	4 feet 6 inches.
Depth of car	4 feet 3 inches.
Crew	5.
Engines	2 Union 125 horsepower.
Speed, maximum	60 miles per hour.
Speed, cruising	40 miles per hour.
Endurance at 60 miles per hour	480 miles.
Endurance at 40 miles per hour	810 miles.

The construction of a rigid airship was authorized by Congress in 1916 and work was begun in that year on the assembly of information regarding design and material. The work was first handled by the joint Army and Navy airship board, which included representatives of both the Army and Navy and to a degree divided the actual work between the two services. This board sent a mission to England, France, and Italy in the spring of 1918. The report of this mission recommended that the construction of a rigid airship in this country be immediately undertaken. The board, in accepting the report and forwarding it with recommendations to the Secretary of War and the Secretary of the Navy, recommended that the actual work of construction be handled by the Navy

Department, as that appeared to be the service primarily interested, and requested; that the board be dissolved. The report of the board was approved by both Secretaries and the board accordingly dissolved, leaving the construction of the first American rigid airship in the hands of the Navy Department.

Among the data regarding rigid airship design obtained during 1918 were sets of plans and descriptive booklets as made by the French from the German airship *L-49,* which had been forced down intact at Bourbonne-les-Bains on October 20, 1917. This was the first comprehensive information in regard to the actual construction of a Zeppelin which the Navy Department had been able to obtain. A certain number of plans and a descriptive book were also received, giving the results of the British study of the wreck of the Zeppelin *L-33,* which had been forced down in England in 1916. As the *L-33,* however, had been set on fire immediately after landing, the information obtained was more fragmentary and of less value than from the *L-49*. As a result of a study of all available information regarding rigid airships, it was concluded that the surest method of constructing a successful airship would be to copy as closely as possible the *L-49*. It was accordingly recommended to the Secretary of the Navy that the construction of one rigid airship, in general a copy of the *L-49,* be approved. The Secretary gave his approval under date of August 9, 1919, and work on the preparation of plans began in September, 1919. This first Navy rigid airship was first known as fleet airship *No. 1,* later as the *ZR-1,* and was finally christened the U. S. S. *Shenandoah.*

The *Shenandoah* was designed by the lighter-than-air technical staff of the Bureau of Construction and Repair (later transferred to the Bureau of Aeronautics) under the direct supervision of Commander J. C. Hunsaker. The design was based on the Zeppelin *L-49,* but as the design progressed the Navy's plans of the *L-49* were found to be incomplete and the wisdom of certain features thereof were doubted. Furthermore, it was known that the *L-49* was not the latest German design. The Navy Department therefore sent Commander Hunsaker to Europe in May, 1920, to make a thorough study of the latest rigid airship practice in Germany and England, and as a result of his recommendations the design of the *Shenandoah* was changed materially. It was decided to fabricate the various parts of the *Shenandoah* at the Naval Aircraft Factory and then to transport these parts to the naval air station at Lakehurst, N.J., and erect the airship at the latter place instead of building a factory specially for the manufacture of rigid airships. This air station was obtained for the lighter-than-air activities of the Navy in 1920, being formerly Camp Kendrick, which the Army had abandoned after the end of the war. The airship was completed in September, 1923, and on October 10, 1923, the ship was christened the U. S. S. *Shenandoah* and placed in commission as a combatant ship of the United States Navy.

In order to obtain a second rigid airship the purchase of the *R-38,* a British rigid airship then under construction by the Air Ministry, was authorized in 1920. Arrangements were also made for the instruction of personnel, both officers and men, in British rigid airship operation, and as a result, 8 officers and 18 men, under the command of Commander Maxfield, United States Navy, were sent to England to receive this training. The *R-38* was patterned after the German *L-33*, which was brought down in England in 1916, and its construction was begun in 1918 shortly before the armistice.

Upon being purchased by the United States Navy, this ship was renamed the *ZR-2*. On August 24, 1921, while still in the possession of the British and undergoing its fourth trial flight the *ZR-2* broke in two parts due to failure of the structure in rear of the after engine car and became a total wreck as a result of this separation and the subsequent fire and explosion. Among those killed in the destruction of this ship were 16 officers and men of Commander Maxfield's detachment, including Maxfield himself, who were on board as observers.

In connection with German reparations, negotiations were undertaken through the State Department in 1921 for the construction of a Zeppelin at the works of the Zeppelin Co. for the United States Government. These negotiations were carried on through diplomatic channels involving the council of ambassadors, were brought to a successful conclusion, and the necessary contracts signed whereby the German Government agreed to build a 70,000 cubic meter Zeppelin rigid airship and to deliver the ship to the United States Navy at Lakehurst, N.J., by a German crew. This ship was designated the *ZR-3* by our Navy and *LZ-126* by the Zeppelin Co., the latter designation signifying the one hundred and twenty-sixth Zeppelin airship. It was arranged that the design and construction of the *ZR-3* was to be carried out under the inspection and subject to the approval of a United States Navy inspector, with offices at the plant of the Zeppelin Co. at Friedrichshafen, and Commander Garland Fulton was sent to Germany as the Navy's inspector. The *ZR-3* was completed in September, 1924, and, after several successful trial flights, was flown across the Atlantic by a German crew under the command of Dr. Hugo Eckner, of the Zeppelin Co. The ship arrived at Lakehurst on October 15, 1924, having made the trip from Friedrichshafen, Germany, a distance of 5,066 miles, in approximately 81 hours. On November 25, 1924, the ship was flown to Washington and christened *Los Anqeles* by Mrs. Coolidge.

The dimensions, weights, and performance characteristics of the Navy's two rigid airships, the U. S. S. *Shenandoah* and the Los Angeles, are as follows:

General Characteristics	Shenandoah	Los Angeles
Air of hull, cubic feet	2,289,861	2,764,461.
Volume of gas cells, cubic feet	2,115,174	2,599,110.
Length	680 feet 2 inches	658 feet 4 inches.
Maximum diameter	78 feet 9 inches	90 feet 8 inches.
Total height	93 feet 2 inches	104 feet 5 inches.
Engines	5 Packard	5 Maybach.
Total Horsepower	1,500	2,000.
Areas of tail surfaces:		
Horizontal (2), square feet	2,870	2,510.
Vertical (2), square feet	2,335	2,510.
Areas of rudders:		
Horizontal (2), square feet	446.2	457.
Vertical (2), square feet	379.1	400.
Area of lateral plane, square feet	42,300	46,800.
Area of cross section, square feet	4,818	6,422.

Weights
(95 percent inflated with helium)

	Shenandoah		Los Angeles	
	Weight, Pounds	Percent gross lift	Weight, Pounds	Percent gross lift
Fixed weights	80,226	62.2	91,030	57.6
Nondisposable weights	20,539	15.9	25,200	16.0
Disposable weights	28,235	21.9	41,770	26.4
Total weights	129,000	100.0	158,000	100.0

Speed and endurance
(95 per cent inflated with helium)

	Shenandoah	Los Angeles
Full speed, knots	51	65
Endurance, full speed, miles	2,250	2,825
Endurance, full speed, hours	50	43
Cruising speed, knots	41	48
Endurance, cruising speed, miles	3,980	5,770
Endurance, full speed, hours	97	119